

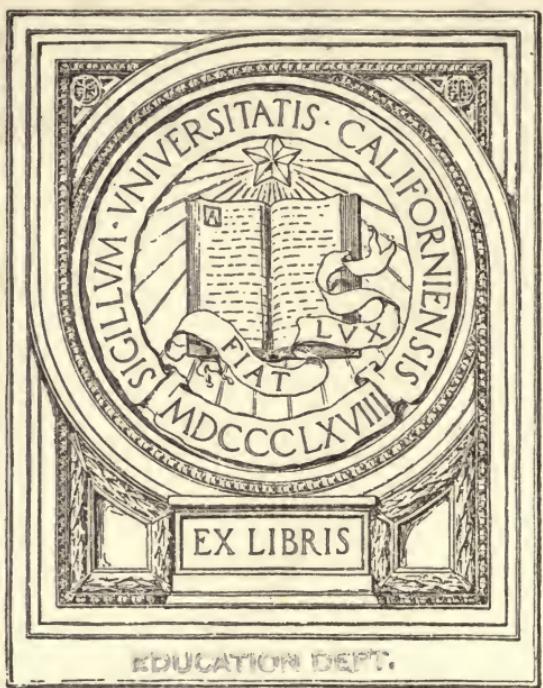
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PHYSIOLOGY  
& HYGIENE  
FOR CHILDREN

EADIE



EDUCATION DEPT.







# PHYSIOLOGY AND HYGIENE

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## FOR CHILDREN

BY

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NEW YORK

CHARLES SCRIBNER'S SONS

1909

90 MINU  
AUTOMOBILIA

QP36  
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## PREFACE

IT is important that every boy and girl shall become familiar, while at school, with the primary laws of health. A knowledge of the structure of the body, its parts, and their uses, is the foundation for an intelligent understanding of these laws. Anatomy and physiology are, therefore, treated here chiefly as an aid to the teaching of hygiene.

In order that children may readily understand the story of their bodies, it is told in clear, simple language, and with a minimum of technical terms.

Great care has been taken in the treatment of each chapter and topic to observe the relative importance of the various organs. Those which have more important functions are described in greater detail than those whose functions are less important. The interdependence of organs has also been kept prominently in view, in order that the pupil may realize that he is learning about an active living body, and not about isolated parts.

The value of this book as a teaching instrument is greatly enhanced by the best illustrations that could be obtained. The authors were given *carte blanche* by the publishers, and instructed to spare no expense in securing pictures that would illustrate the text in the best possible manner. Color has been used to make the illustrations more attractive, and also to make

it easier to differentiate parts, but there has been no uniform attempt to imitate the natural color of the parts.

The law requiring that twenty-five per cent. of the text matter shall treat of "the nature and effects of alcoholic drinks and other narcotics" has been complied with. The injurious effect of alcohol upon different organs is stated plainly and concisely; and, in addition to that, as much emphasis as possible has been placed upon the positive benefits in improved health and strength which arise from abstinence from the use of alcoholic drinks and tobacco. In order that this lesson may make a deep and lasting impression, it is presented in the concrete form of letters written by men whose opinions will at once be accepted as worthy of confidence.

The authors take pleasure in acknowledging their obligations to the gentlemen who kindly furnished the letters contained herein, and also to Mr. M. Anagnos, Director of The Kindergarten for the Blind, in Boston, Mass., for annual reports containing the story of Thomas Stringer.

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## CHAPTER I

### THE BODY

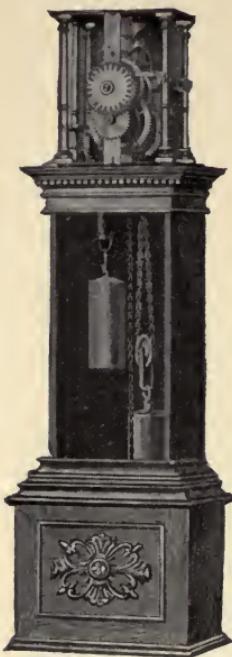
A LITTLE boy whose name was Charles lived in a great city. In the hall of his father's house stood a tall clock, and little Charles used to stand before it and watch the heavy pendulum swing back and forth, and listen to the regular tick-tock, tick-tock, like a voice speaking to him. At times he would hear a sudden click, and then out would ring a bell, clear and sweet, telling that another hour had passed.



THE OLD HALL  
CLOCK.

and wonder about it.

What made the pendulum swing?  
What made the hands go round?  
What made the bell ring at exactly the  
right time every hour? Little Charles  
could not tell. So day after day he  
would stand and watch the old clock



INSIDE THE CLOCK.

One morning when he came down stairs there was no sound in the hall. He looked up at the clock and saw that the pendulum was still. The clock had stopped. Later in the day a strange man came to fix it. Charles watched him as he took off the front. Inside were wheels and chains and weights. The man took the wheels out one by one, polished them, oiled them, and put them back, fitting each part nicely to the other. Then he wound up the weights, put the front on the clock again, started the pendulum to swinging, and once more Charles heard the pleasant tick-tock, tick-tock, to which he loved to listen. Now he knew what made the hands go round, the pendulum move, and the bell ring. It was the wheels and the chains and the weights inside.

While Charles had often wondered about the clock, he had never thought very much about himself. And yet a boy is much more wonderful than a clock. It can move its hands only round and round; he can move his hands in every direction. It can say only tick-tock; he can say whatever he wishes. It can

stand only where it is placed; he can run and jump and play. What gives a boy the power to do all these things? Would you like to know?

The body of a boy, like the body of a clock, has many strange things inside—not wheels, chains and weights, but other things which are just as strange, and which all work together. The picture on page 11 shows part of a body with the front taken off. Look at it and you will see some of these things.

From this little book you can learn something about your body and the things inside it. Each chapter tells you the name of some part of the body, how it looks, and where it is; that is ANATOMY. Next, it tells you the use of each part; that is PHYSIOLOGY. And then it tells you how to take care of each part; that is HYGIENE.

**The body.**—We often call that part of a man which you see in the picture the body, but its real name is the *trunk*. The upper part of the trunk is the *chest*, the lower part is the *abdomen*. Joined to the trunk are the head, arms and legs. All these together make the body.

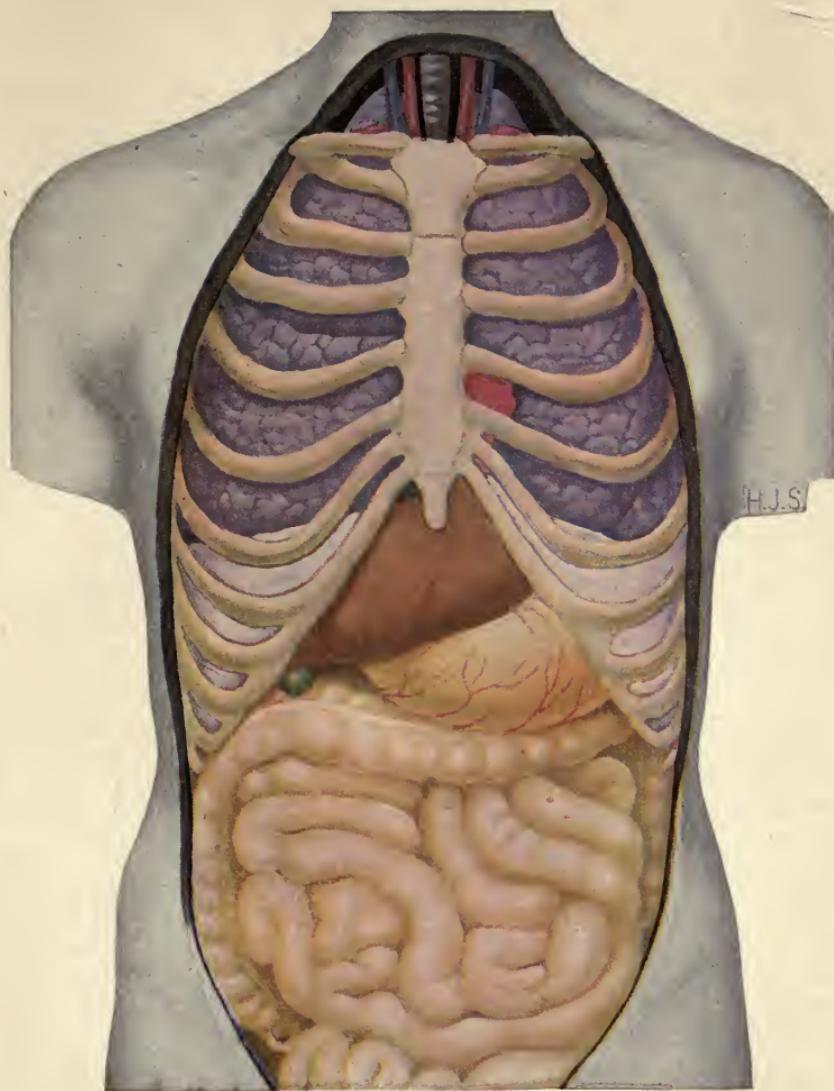
**Organs.**—The works of a clock are called a machine. They are made to do special work, and are afterwards put into the body of the clock. The

strange things that you see in the chest and abdomen also do special work, but they are called organs. They grow in the body from the first, and are parts of it. Each part of the body that does special work is called an organ. The eye is an organ of sight. The ear is an organ of hearing. The hands and feet also are organs.

Many organs are very delicate, and so we find them placed in hollow cases of bone, called cavities, to keep them from being injured. For this reason the brain, which is the organ of the mind, is shut up in the skull, and many important organs are shut up in the large cavities of the trunk.

Look at the picture on page 11 and you will see the ribs and the breast bone, which protect the cavities. Behind the ribs are organs called lungs. In the centre of the neck you can see a tube called the windpipe, which extends upwards from the lungs. The air which you breathe passes through the windpipe into the lungs. Both the lungs and the windpipe have been colored purple in the picture.

Turn to the picture on page 14. The ribs have been taken off, one lung has been taken out, and the other lung has been drawn back so that you can see the cavity of the chest. There you will see an organ



A VIEW OF THE INSIDE OF THE TRUNK.

(See Appendix for Key.)

called the heart, colored red. Above the heart are red and blue tubes which go from it to other parts of the body. Just under the heart and lungs you can see the partition which separates the chest from the abdomen. Below this partition is an organ called the liver. Below the liver is the stomach. In the picture the liver has been colored brown, and the stomach yellow, with red lines over it. A tube goes from the mouth down to the stomach. It is just behind the windpipe, and so cannot be shown in the picture. It is through this tube that food passes from the mouth to the stomach. Below the stomach, neatly folded and curled up, is the intestine.



THE CELLS OF AN ORANGE: LITTLE SACS FULL OF JUICE.

Although the body has many organs, all work together and help one another. If one organ is in pain and cannot do its usual work, other organs share

the injury and are unable to do their work well.

**Cells.**—If you cut open a ripe orange and pick it apart carefully, you will find that it is made up of a great number of little sacs which are full of juice.

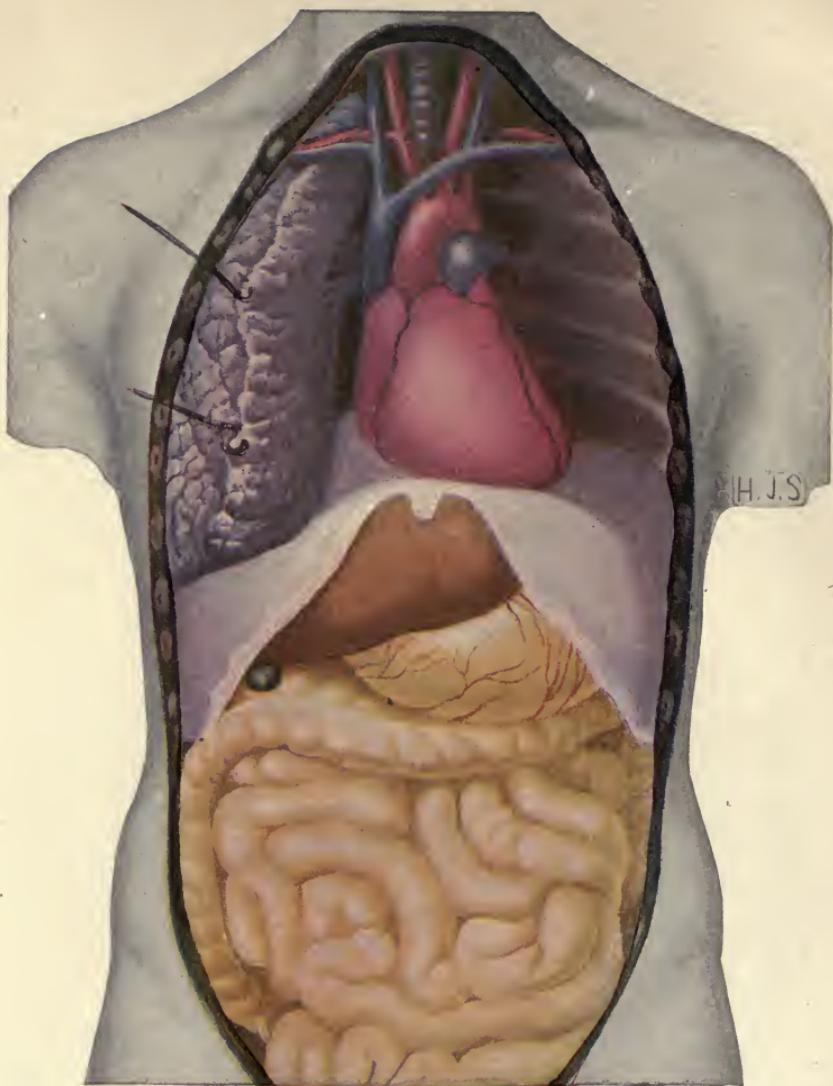
These are called cells. They are packed closely and are held together by small threads, or fibres. The fibres in the orange are found either as small threads, or woven together in thin sheets like tissue paper.

All vegetables and animals are made up of cells. Every part of your body, every organ in it, all your muscles and bones, your skin and hair are built up of cells. Most cells are so small that you cannot see them unless they are made to look much larger than they really are by the use of a microscope. This is true, for example, of the cells of a grain of wheat, a potato or a blade of grass. It is also true of the cells of muscle, bone, skin, and hair.

Cells are held together by little fibres. Many of these fibres are joined together into sheets, or tissues. Because these tissues connect cells and hold them together, they are called connective tissue.

**Growth and health of the body.**—We grow rapidly in early life. As the years pass by we grow more and more slowly, but continue to grow until about our twenty-fifth year. Part of a child's food is used to make him grow, and so he requires more to eat in proportion to his size than a grown person does.

Exercise and work that is not too hard promote growth and health.



ANOTHER VIEW OF THE INSIDE OF THE TRUNK.

(See Appendix for Key.)

Plain wholesome food and pure drinking water are necessary to health.

Pure air and sunshine are also necessary for health and growth. Notice the sickly plants that are kept too long in a north window, or in a cellar, where the sun cannot shine on them. Notice, too, how pale are the unfortunate children who are crippled and unable to run about outdoors. Whatever else you may be afraid of, never be afraid of sunshine and fresh air.

The continued use of alcoholic liquors and tobacco often injures the body. The harm that they do to some parts of the body may be serious enough to require the aid of a physician, who treats such injury with as much care as if it were due to accident or contagion.

Besides the physician, the employer of labor knows that alcoholic liquor and tobacco injure the body; for he finds that they unfit a man for doing his best work. In fact, many people refuse to employ a young man who uses alcohol or cigarettes; and it is an advantage to a young man in any calling or profession if it is known that he abstains entirely from the drinking of alcoholic liquor.

The following letter from Mr. John Claflin, President of one of the largest dry goods companies in the United

States, illustrates the opinion held by prominent business men in regard to the drinking of alcohol:

THE H. B. CLAFLIN COMPANY,  
NEW YORK, April 26, 1907.

*My Dear Sir:*—I do not knowingly employ a young man who uses alcohol. Its use, even occasionally, renders him unreliable and impairs his ability to do intelligent and constant work. In the struggle for success in life, the total abstainer has a great advantage over the moderate drinker. The immoderate drinker is out of the race.

Very truly yours,

(Signed) JOHN CLAFLIN,

President.

**We have learned that:**

1. The body consists of distinct parts.
2. Anatomy tells us what the different parts of the body are like.
3. Physiology tells us the uses of the parts of the body.
4. Hygiene tells us how to take care of the body.
5. An organ is any part of the body that has a special work to do.
6. Some of the most important organs, such as the brain and heart, are contained in cavities in the body.
7. The body is made up of cells held together by connective tissue.
8. The use of alcoholic liquors and tobacco often injures health.

## CHAPTER II

### BONES

**The framework of the body.**—In this picture you can see a cottage which carpenters are building.



THE FRAMEWORK OF A COTTAGE.

nail boards and shingles upon the outside, and will lay floors and put in doors and windows. The framework will support all of these, and the finished cottage will look like the one in the second picture.

The human body has a framework of bones which gives to the body its general

They have fastened together strong pieces of timber, to make the framework. This framework will give shape to the cottage, and support its parts. The carpenters will



THE FINISHED COTTAGE.



THE FRAMEWORK, OR SKELETON, OF THE BODY.

shape. It supports the flesh which is laid over it, and also protects the tender parts of the body which are placed within it. If the skin and flesh were removed from a body, so that you could see this framework, which we call the skeleton, it would look like the picture on page 18.

**What bones are made of.**—Bone is a hard substance. You can find out by two little experiments something about the materials of which bone is made.

Place a bone in a hot fire for three or four hours. It will keep its shape, no matter how long you burn it; but if you try to handle it after it is burned, it will crumble to pieces. The part of a bone that remains after it has been burned is called mineral matter.

Get two ounces of muriatic acid at a drug store, and put the acid and a pint of water into a bottle. Then put the leg-bone of a chicken into the bottle, and leave it there four days. When you take the bone out, you will find it so soft that it can be tied into a knot. The



A CHICKEN'S  
LEG-BONE TIED  
INTO A KNOT.

part of a bone that remains after it has been in acid is called animal matter.

The fire burned away the animal matter of one bone, and the acid dissolved out the mineral matter of the other bone.

The animal matter in bone resembles gristle. It makes the bones tough.

The mineral matter consists largely of lime. It makes the bones hard and strong.

In early life the bones are elastic and will bend before they break. As people grow old their bones become less elastic and more brittle. It was long taught that this brittleness was caused by a loss of animal matter and an increase of mineral matter. Now, however, it is taught that bones become brittle with age because they lose both animal and mineral matter. On account of this loss the bones of old people are not strong and break easily.

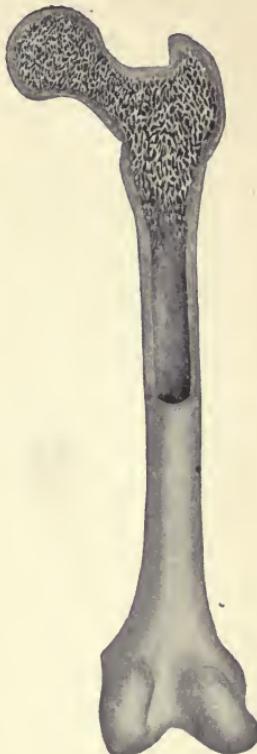
**How bones look.**—If you examine a short or a flat bone which has been well dried, you will find that the outer part is hard and firm. When the bone is broken, the inner part is seen to be like a sponge, full of small holes. The holes in the spongy part are connected with one another, so as to form little canals.

A long bone consists of a round shaft, with enlarged ends. The material of the ends is like that of a short bone. If you saw the shaft across, you will see a ring of hard bone with a hollow space running through it from end to end. This hollow space, when the bone is fresh, contains a yellow substance called marrow, which consists largely of fat and small blood tubes.

A fresh bone is pinkish white, because it contains blood.

An old dried bone is white, because it has lost the blood that was in it.

**Joints.**—In order that the bones of the body may make a framework, they must be fastened together, just as pieces of timber must be fastened together to make the framework of a cottage. A place in the skeleton where bones are fastened together is called a joint. Every one has seen the hinges on a door. They are simply joints of metal, which allow the door to open and close. Many of our joints are



A LONG BONE.

like hinges; they allow bones to move upon one another easily.

To understand the value of such joints you have only to try to play ball without bending your arms at the elbow, or to write without bending your fingers at the knuckles, or to walk without bending your knees.

Some joints, like those of the elbow and shoulder, allow the bones to move freely. Others, like those of the spine, allow the bones to move only slightly; while the joints of the skull are fixed—they do not allow the bones to move at all.

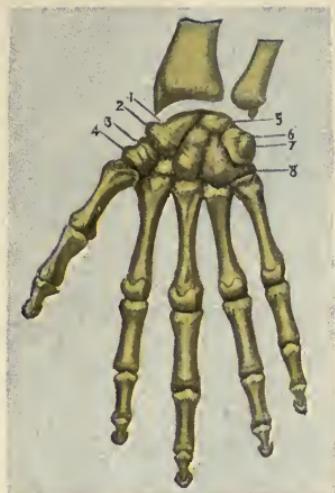


LIGAMENTS OF WRIST  
AND HAND.

The ends of the bones at joints which allow movement are covered with a tough, smooth substance called cartilage, which is elastic like rubber.

The bones are held together at the joints by short, tough, white, glistening bands of connective tissue, called ligaments. You can see the ligaments of the wrist and the hand in this picture.

Ligaments are soft and bend easily, so as to allow great freedom of movement; yet they are strong, and



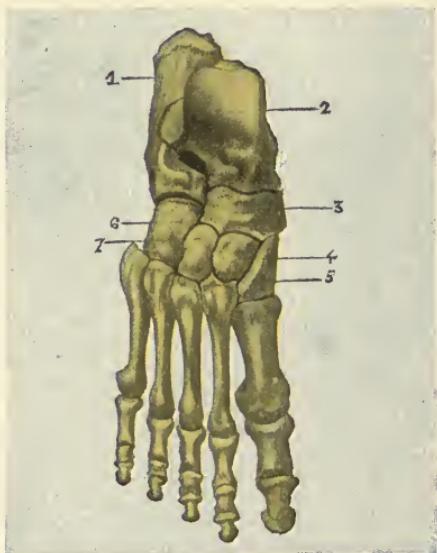
BONES OF THE WRIST AND HAND.

which enough of this fluid is made to keep the ends of the bones slippery, so that they move smoothly upon one another.

**Chief bones of the body.**—It takes a great many bones to make the skeleton. There are about two hundred. This seems a large num-

tough, and hold the bones securely in their right places.

The hinges of a door sometimes work with difficulty. A drop or two of oil will cause them to move freely. Many of our joints are supplied with a fluid which helps them to move easily, as oil helps the hinges. The inner surfaces of the ligaments have a smooth lining, in



BONES OF ANKLE AND FOOT.

ber, but all are needed. Each has its own place and its own use.

Look at the pictures on page 23 and compare the bones of the wrist and hand with those of the ankle and foot. The wrist and hand contain twenty-seven bones. Can you find them all in the picture? The ankle and foot contain twenty-six bones. Count them in the picture. There are eight small bones in the wrist and seven in the ankle and instep. How many do you see in the palm of the hand? How many in the foot between the instep and the toes? How many in the thumb? in the great toe? How many are there in each of the other toes? How many in each of the fingers? The bones of the wrist, hand, and fingers are arranged in rows, and held in place by strong ligaments. These ligaments are so elastic that the hand and fingers can move rapidly and easily in different kinds of work and play. The bones of the foot, ankle, and instep also are held together by strong and elastic ligaments.

You see that the hands and feet are made on much the same plan, yet they serve very different purposes. It is not easy to use the feet as we use the hands, to hold and handle things, because the toes are short, and the bones of the great toe lie side by side, or parallel

with the bones of the other toes. The bones of the thumb are not parallel with those of the fingers, but are so arranged that the tip of the thumb can be made to touch the tips of the fingers. This is important, for it gives us power to grasp and hold with the hands.

Now turn back to the picture of the skeleton on page 18 and compare the bones of the arm with those of the leg. How many bones do you find from the shoulder to the elbow? From the hip to the knee?

There is one small bone which forms the front of the knee and protects it. It is called the knee-cap. The elbow has no such bone. How many bones extend from the elbow to the wrist? How many extend from the knee to the ankle? Which is the largest bone in the skeleton?

The backbone, or spine, is made up of thirty-three bones, which are placed one upon another like spools on a string. In children each bone is separated from the one above it and from the one below it by a thin layer of cartilage. This cartilage allows the bones to move, so that the spine may bend and turn easily. The cartilage acts also as a cushion to prevent injury from a sudden jar. In grown people the nine lower bones of the spine are united so as to form only two bones.



THE SPINAL  
COLUMN.

Notice this picture of one of the bones of the spine. The small holes on either side are for blood tubes, while the large hole in the centre is for a delicate cord which passes down from the brain, and is called the spinal cord.

The spine is sometimes called the spinal column, because it forms a strong column, or pillar, to support the upper part of the body.

The skull is made up of a number of bones which are joined at their edges. The picture on page 27 shows where some of the bones are joined.

The skull forms a box that holds the brain. In the front part of it are two hollows, called sockets, for the eyes.

Only the upper part of the nose is made of bone. The lower part is composed of cartilage.



ONE OF THE BONES OF THE SPINE.



A VIEW OF THE SIDE OF THE SKULL.

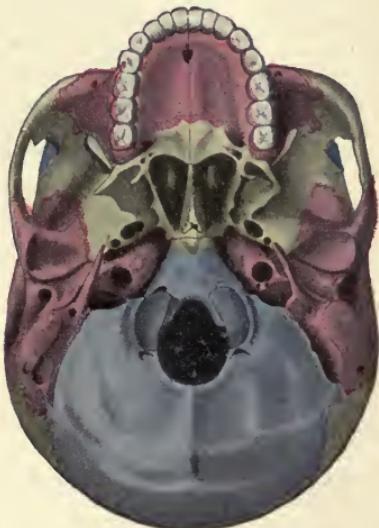
the spinal cord extends from the brain downwards into the spine.

The ribs form a bony cage which protects the heart and lungs. All the ribs are fastened to the spine, and most of them to the breast-bone. They are moved gently upwards and downwards as we breathe.

Look at the picture on the next page and tell how

The lower jaw is fastened to the skull by two joints, one on each side of the face. The jaw can move up and down, and also from side to side.

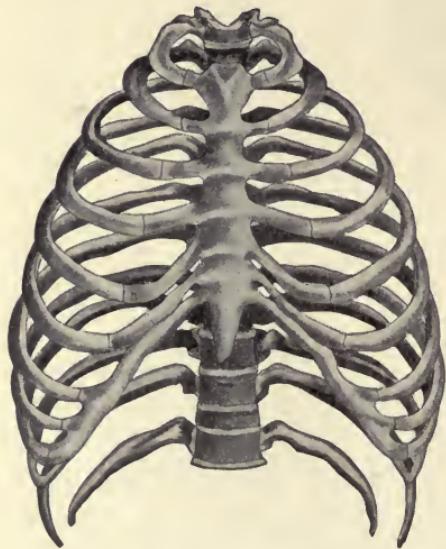
The picture below gives a view of the base of the skull. It shows the hole through which



A VIEW OF THE BASE OF THE SKULL.

many ribs you see on each side. How many on each side are fastened directly to the breast-bone? How many are not fastened to anything in front? How many are fastened in front to ribs above them?

The collar-bone can easily be felt at the upper part of your chest in front. It extends from the shoulder to the breast-bone, and serves as a prop to the shoulder.



THE RIBS AND BREAST-BONE.

The shoulder-blade, as you will see from the picture of the skeleton, is a strong bone which is spread out like a fan over the upper ribs at the back. At the centre, from which the fan spreads, is a shallow

cup-like cavity into which the upper end of the arm-bone fits, and makes the shoulder-joint. The shoulder-blade is connected with the collar-bone also.

**Hygiene.**—We often hear that “as the twig is bent the tree is inclined.” This is certainly true of the bones. The soft bones of children may be bent

into awkward shapes by wrong positions and unsuitable clothing. If the bending continues, the bones will harden into these shapes and the body will be deformed.

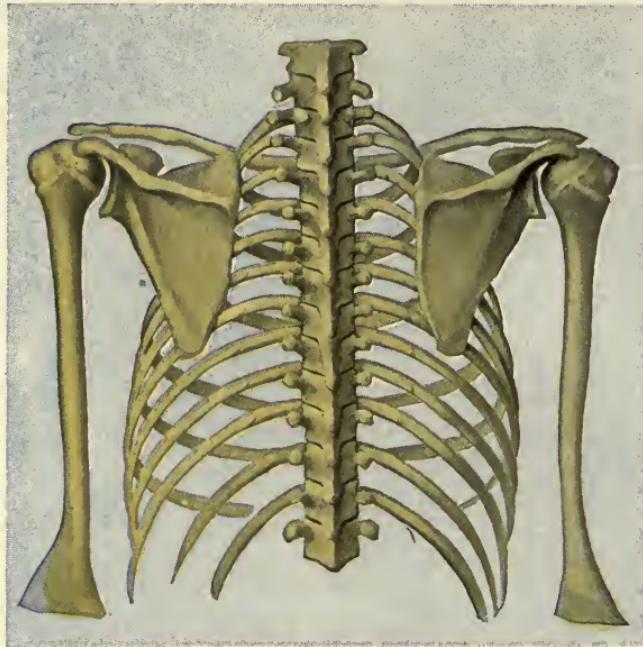


X-RAY PHOTOGRAPH OF BONES OF  
FOOT WITHOUT SHOE.

X-RAY PHOTOGRAPH OF BONES OF  
FOOT IN SHOE.

The foot may be forced out of shape by tight, or badly fitting shoes. The picture on the left was taken without the shoe, and you see the natural shape of the foot. The picture on the right shows how the bones of the foot may be pressed out of shape by a tight shoe.

The ribs may be pressed inward by tight clothing about the waist. In this way internal organs are sometimes pushed out of place, so that they cannot do their work as they should.

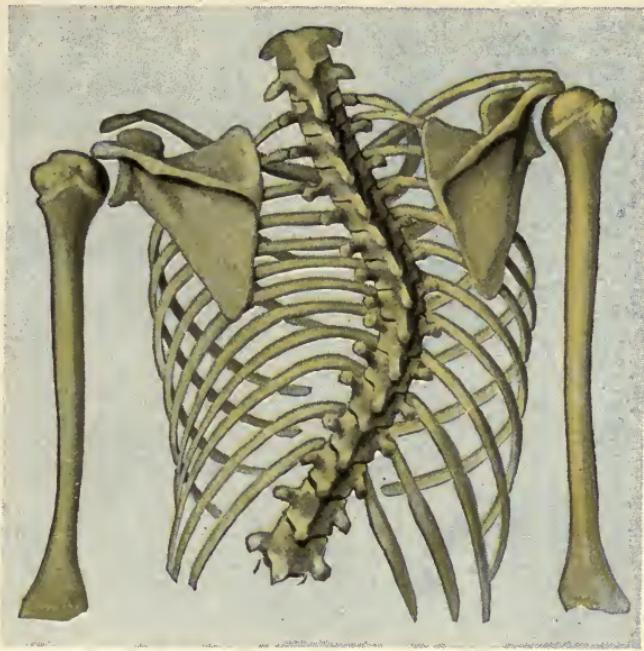


FROM AN X-RAY PHOTOGRAPH OF A STRAIGHT SPINE.

Every one should form the habit of sitting and standing upright. By constant stooping you may become round-shouldered. If you form the habit of holding your body in a one-sided or stooping position you may gradually grow out of shape, and you

will find it very difficult, or even impossible, to straighten up again.

For this reason desks in a school-room should always be suited to the height of pupils. If the desk



FROM AN X-RAY PHOTOGRAPH OF A CURVED SPINE.

is too high, the right shoulder is raised above the left, and the body will be bent to one side. If the desk is too low, the habit of stooping will be formed, and the pupil will become round-shouldered. Here we have the picture of the spine of a girl when she was seven-

teen years of age. Her spine became curved while she was attending school.

The seat should be so arranged as to allow the feet to rest comfortably. If the feet have no support their weight may cause the thigh bones to be bent out of shape.

A sudden twist or wrench of a joint may over-stretch or tear the ligaments and produce an injury which is called a sprain. A sprained joint should always have rest.

**We have learned that:**

1. A framework of bones gives shape to the body, and supports and protects other parts of it.
2. Bone is a hard substance composed of animal matter and mineral matter.
3. The outer part of all bones is hard and firm, the inner part is either spongy or hollow.
4. A joint of the body is a place where two bones are fastened together.
5. The ends of the bones of a movable joint are covered with cartilage, and are held together by ligaments.
6. Movable joints are furnished with oil.
7. Bones may be forced out of shape and may remain so.

## CHAPTER III

### MUSCLES

**What muscles do for us.**—A bit of stone from the mountain side may travel down to the seashore and become one of the pebbles at the water's edge, but in its long journey it never moves itself. The rain washes it down into a stream, and the stream carries it to the shore.

A seed that falls to the ground would perhaps grow better in the soil of a neighboring field, but it cannot get there unless the wind carries it. It has life, but it has no power to move.

Watch, however, the graceful movements of a bird as it flies from tree to tree. It can make these movements because it has muscles. The movements of all animals, from the tiny insect to the great elephant, are due to muscles. Even the slightest motion of the body, such as the winking of an eyelid, is produced by muscles.

When a ball is lying on the floor it has no power to move itself, and when rolling it has no power to stop itself. But if a boy is running he can stop when he chooses, because he has muscles. Our muscles not



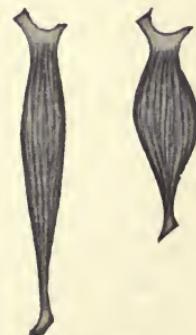
THE MUSCLES OF THE SURFACE OF THE BODY.

only enable us to move; they also enable us to keep from moving. It is by means of our muscles that we can hold an arm out straight from the shoulder, and sit or stand upright. When we become weak from illness, we have to lie in bed because our muscles cannot hold us up.

The muscles serve still another purpose. They cover the skeleton and give to the body its graceful curves and beautiful outline.

Very few boys and girls have ever seen a whole muscle, but every one has seen a beefsteak, and that is a slice of muscle. We are eating muscle whenever we eat the lean flesh of a chicken, lamb, or other animal.

**How muscles act.**—On the left we have a picture of a muscle taken from the leg of a frog. If this were a real muscle instead of a picture, and we were to prick it with a pin, it would at once become shorter; that is, it would contract. It would then look like the picture on the right. After contracting, a muscle will return to the shape that it had before; that is, it will relax. It is by means of their power to contract and relax that the muscles are able to move the body.



LEG MUSCLE OF  
A FROG.

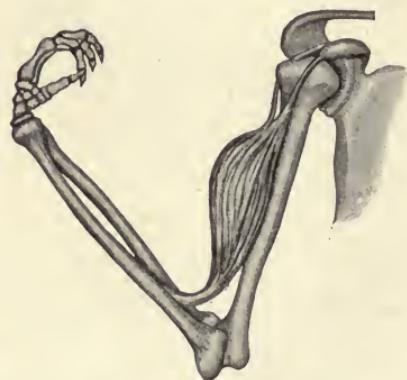


UNCONTRACTED  
MUSCLE OF  
UPPER ARM.

The upper end of this muscle is fastened to a bone at the shoulder, and the lower end is fastened to another bone below the elbow. When this muscle contracts, it pulls on the bone to which its lower end is fastened, and the forearm and hand are moved upward.

Bare your right arm, and hold it up before you, with the palm of the hand toward you. Close your hand and then open it again. Watch the arm while you do this, and you will see muscles lying along the front of it contract and pull your fingers down. Then muscles lying along the back of it contract and pull the fingers up again.

Here are pictures of the bones of the arm, with one muscle in its natural position. The other muscles of the arm are not shown.



CONTRACTED MUSCLE OF UPPER  
ARM.

**Why muscles contract.**—In our bodies there are many silvery threads, called nerves, which, like telegraph wires, carry messages. Whenever you decide to move your arm, your hand, or any part of your body, a message is sent out by your brain. This message travels quickly along a nerve to the proper muscles, and on its arrival a contraction of those muscles takes place. Like faithful servants they obey your slightest command.

**Kinds of muscles.**—Some muscles, such as those of the arms and legs, contract only when we order them to do so. They are under the control of our will and for this reason they are called voluntary muscles.

There are many other muscles which are not under the control of the will. We can neither make them contract nor prevent them from contracting, so they are called involuntary muscles. Your heart is made up of involuntary muscles. You have no control over its action; it keeps on beating whether you are awake or asleep.

**Shapes of muscles.**—Muscles are of many different shapes and sizes. Some are thin, round and long; some are short and broad; while others are spread out like a fan. The shape and size of each are suited to the work it has to do.

**What muscles are made of.**—Muscles are made of very fine threads, or fibres. Here is a picture of three fibres of voluntary muscle, very much magnified, and also a picture of a bundle of fibres. Each voluntary muscle consists of bundles of these fibres. The

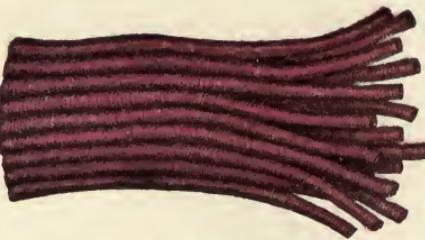


THREE FIBRES OF VOLUNTARY  
MUSCLE. (Magnified.)

into fine threads, and yet consists of many fibres.

**The tendons.**—Some muscles are attached at both ends directly to bone. Other muscles end in white glistening cords which are fastened to bone. These cords are called tendons. The tendons are composed of hard connective tissue, which is tough and strong and will not stretch.

If you look at the back of your hand while your



A BUNDLE OF MUSCLE FIBRES.  
(Magnified.)

fingers are working rapidly, you will see, moving under the skin, the tendons which belong to the muscles on the back of the arm.

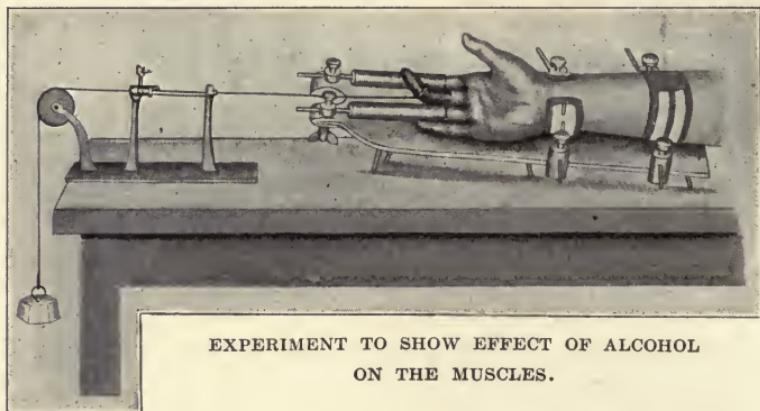
**Exercise.**—Our muscles require food. They get it from the blood, through little tubes. Each time a muscle contracts these little tubes become larger, and the muscle receives an increased amount of food.

Exercise causes the muscles to contract again and again. While they are contracting they get more food from the blood, and therefore increase in size and strength. It is because of more exercise that the farmer's boy who works in the fields is generally stronger than the boy who lives in the city. The blacksmith can pound the red hot iron with great force because his muscles are large and strong, but his muscles have become large and strong because for years he has been pounding the iron.

Muscles that are not used soon become small and weak, for they do not receive proper supplies of blood, and so are not well fed. This is shown in the case of a broken arm. After an arm has been in a sling for a few weeks its muscles become so weak, from lack of exercise, that it is hard for them to make even ordinary movements.

All parts of the body should be exercised, so that

one part may not remain weak while other parts become strong. Not all people are benefited by the same kind of exercise. Some tire sooner than others. Some need harder work than others. Therefore it is foolish to insist on taking any particular exercise merely because some one else finds it useful. Such exercises as those with light weights, which can be done easily



and quickly, will benefit a person more than exercises which require all his strength.

**Effect of alcohol on the muscles.**—Alcohol weakens the muscles. Careful experiments to show that muscles are affected by small quantities of alcohol were recently made both in Switzerland and Belgium.

This picture shows how these experiments were made. The arm was fixed on a board by means of

two clamps, so as to keep it still. The first and third fingers were placed in tubes, which kept them from interfering with the second finger. A string, fastened to the second finger, was passed over a pulley and attached to a weight.

Every time the second finger was bent upwards the weight was lifted. The experiments consisted in bending and straightening out the finger until its muscles became so tired that they could not lift the weight again.

It was found that the muscles of the finger could do more work when no alcohol was taken than they could when even a small amount was taken.

A man who develops his muscles by exercise until they become large and strong is called an athlete. The following letters show that when athletes are trying to become as strong as possible it is usual for them to do without alcohol and tobacco. This proves that the use of either alcohol or tobacco is considered injurious to the muscles.

THE CORNELL NAVY.  
ITHACA, N. Y., November 7, 1899.

*Gentlemen:*—Answering your favor asking my opinion as to the use of alcoholic liquors and tobacco by men who are training for rowing contests, I would say :



A CREW OF ATHLETES.

First : As to alcoholic liquors, I do not believe in the use of any form of alcoholic liquor for men in training. I know that in England, and sometimes in this country, it is used by other trainers, but I have found, in my experience, that young men are much better off, and do better work without alcoholic stimulants than with them, and they are, therefore, absolutely prohibited in our training. The use of alcohol in any shape I think wholly unnecessary for any young man who has sufficient bodily health to be athletic, and in many cases, as I know, it is positively injurious if used.

Second : As to tobacco, I believe young men do better work when not using tobacco than when using it, and it is prohibited in our training here at Cornell University.

Respectfully yours,

CHAS. E. COURTNEY.

NEW YORK, *March*, 12, 1900.

*Dear Sir:*—Replying to your favor of the 10th inst., I will say that I do not use alcoholic liquors in any form, neither do I use tobacco. I have never used them. I do not believe any athlete can meet with success who does use either alcohol or tobacco.

Respectfully yours,

FRANK L. KRAMER.

(*National amateur cycling champion of America, 1898, 1899.*)

NEW HAVEN, CONN., *Jan.* 11, 1900.

*Dear Sir:*—Yours of the 10th inst. at hand. It is absolutely necessary for a college or school athlete who is striving to win a place on any team to have endurance; especially is this true in rowing and football. This can be accomplished to the greatest degree only by abstaining from the use of tobacco and alcoholic drinks while in training for said team.

Very truly yours,

M. F. McBRIDE,

*Capt. Yale Football Team of '99.*

173 BROADWAY, NEW YORK, *April* 4, 1901.

*Dear Sir:*—There is nothing which goes to make a better athlete, nothing which gives a man greater power of endurance than total abstinence from the use of alcoholic drinks and tobacco.

At the opening of college, all the candidates for the football team are called together and informed of the plans for the year. They are also told at what date rigid training will begin. Those men who are using liquor and tobacco have now a chance

gradually to leave them off altogether, so that at the set date every one starts in on good, hard, conscientious work.

At Princeton, there have been several opinions given in regard to the use of ale at the training table. In some years the men who wished to have it have been given one glass of ale with their dinner, and many believe in its use. Beer and other alcoholic liquors are never used. I think a team is better off without any of them.

No one is expected to use tobacco. A man who is using tobacco and alcohol contrary to orders during the season is easily detected, and is dropped from the squad.

Yours truly,

WILLIAM H. EDWARDS,

*Capt. '99 Football Team,*

PRINCETON UNIVERSITY.

**We have learned that:**

1. Muscles enable us to move.
2. Muscles give a pleasing shape to the body.
3. Muscles can contract and relax.
4. Muscles which are fastened to bones pull on them in contracting, and thus produce movement.
5. Muscles contract because messages from the brain come to them along nerves.
6. Some muscles are voluntary, others are involuntary.
7. Muscles are made up of fibres.
8. Some muscles end in tendons, which are fastened to bones.
9. Exercise makes muscles stronger.
10. Muscles can do better work without alcohol and tobacco than with them.

## CHAPTER IV

### THE FOUR KINDS OF FOOD

**Food builds up the body.**—Everything wears away as time passes. Your shoes wear out and have to be repaired with leather. Your warm winter stockings wear out and have to be darned with yarn. Boys' shirts and girls' dresses wear out and have to be mended with cloth.

Our bodies, too, are wearing out from day to day and have to be repaired,—not with leather, or yarn, or cloth, but with bread and milk, meat and vegetables, and other things that we eat and drink. Some of your skin wears out every day. If you scrape the skin of your arm gently with a knife, you will collect on it a great many particles that are just ready to fall away. Even your muscles and your brain wear out, although you cannot see the worn-out particles. But as each particle wears out it is washed away and a new one is made in its place. The material out of which these new particles are made is obtained from food. Food is any substance that can be used to nourish the body without injuring it. Besides being used for repair, food produces the heat of the body,

the case of children some food is used up also in growth.

**Kinds of food.**—We must eat different kinds of food if we wish to be strong and healthy, because no one kind can supply all the different materials that are needed to build up every part of the body and to furnish it with heat and power to work. This is the reason why we have several kinds of food on our tables for each meal. Sugar is a useful food, but if you ate sugar for breakfast, dinner, and supper, day after day, and ate nothing else, you would become very thin and weak, and, in the end, would starve to death.

It is easy to make a long list of different articles of food that are commonly used. Some of these are beef and mutton, turkey and chicken; fish and oysters, potatoes and cabbage; bread, butter, and eggs; pie and cake; fruits; water, milk, tea, coffee, cocoa, and chocolate. This by no means ends the list, yet in spite of the many different articles that might be named, there are only four different kinds of food, and everything that you eat belongs to one or more of these four kinds.

**Proteid.**—One of the four kinds of food is called proteid. This is a strange name, yet you have seen

proteid many times. The white of an egg is one kind of proteid, and is called albumen. Before it is cooked it has a clear, glassy appearance, and is quite soft, like thin jelly. You can see through it very much as you can see through glass.

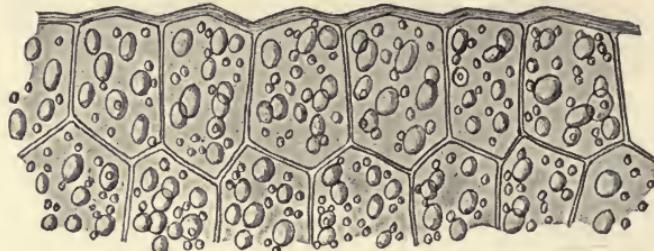
Muscle—that is, lean meat of all kinds—is made up largely of proteids. If you should look at a thin strip of muscle through a microscope, you would see the clear, glassy-looking proteid, somewhat like the white of an egg in appearance. Milk and cheese have much proteid in them. Many vegetables and grains also contain it.

The chief use of proteids is to build up and repair the tissues of the body, but they can also be used to produce heat and power to work.

**Starch and sugar.**—Starch and sugar are another of the four kinds of food.

We may not think that we are eating starch when we eat bread, cake, rice, or potatoes; yet all of them contain much starch. It forms a large part of all grains, such as wheat, corn, oats, and rice. Food containing starch is sometimes called starchy food. Starch and sugar are considered the same kind of food because after starch has been eaten it changes into a form of sugar.

Here is a picture showing how the starch in wheat looks through a microscope. Each of the little starch grains is enclosed in a thin but very tough envelope.

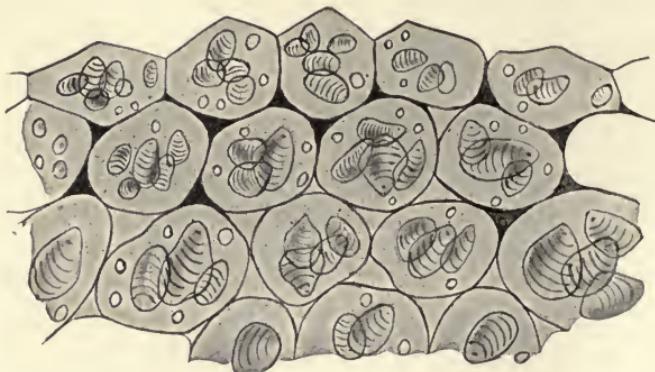


STARCH GRAINS IN WHEAT. (Magnified.)

When starch is cooked, its grains swell up and burst their envelopes.

Below is a picture of the starch grains of a potato as they appear when seen through a microscope.

Starchy food is needed to produce heat and power to work.



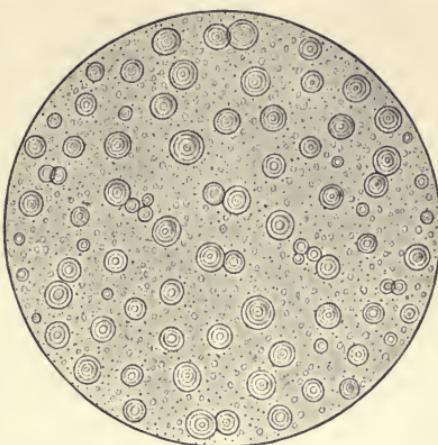
STARCH GRAINS IN POTATO. (Magnified.)

**Fat.**—Fat is the third kind of food. As a rule, children do not like fat meat, but they like butter, and yet butter is only fat obtained from milk. Here is a picture of a drop of milk as it looks through a microscope. It shows the fat, or butter, in little round particles.

Fat also produces heat and power to work.

**Mineral food.**—The fourth kind of food is mineral food, and consists of water and salt. Common table salt is a very important food. You eat even more of this salt than you think, for nearly every article of food contains it. It is found in all the fluids and tissues of the body. You could not live without it. In his book, "In Darkest Africa," Stanley tells of regions where savages are accustomed to travel many hundreds of miles under great difficulties to obtain a supply of salt. Many of the lower animals also have a natural craving for it.

Besides the common salt that we have on our tables



ROUND PARTICLES OF FAT IN A DROP OF MILK SEEN UNDER A MICROSCOPE.

there are many other kinds,—salts of lime, salts of potash, salts of sodium, salts of phosphorus, salts of iron, as well as others. Small portions of some of these salts are contained in almost every article of food that we eat or drink.

One use of salts is to help in making bone. The hardness of bone is due to the lime salts it contains.

Water, our natural drink, is also a mineral, and one that we cannot live without. We need it to dissolve our food, and also to dissolve and wash away the waste matter. More than half of our body consists of water. In addition to that which we drink, we get a great deal of water in beef, bread, potatoes, and other things we eat.

It is a very important matter to get pure drinking water. If we get it from a well, the well should be kept thoroughly clean. The ground around the well should, if necessary, be raised so as to be higher than the ground farther away. The surface water will then run away from the well instead of draining into it. Every care should be taken to allow nothing near the well which can in any way make the water impure. Impure water may be very injurious, for it may carry germs of disease. Even water that is clear and sparkling may be harmful.



THE GROUND AROUND THE WELL SHOULD BE HIGHER.

Many towns and cities take their drinking water from streams or lakes by means of underground pipes. Every one who lives on the banks of such streams should be careful not to allow filth of any kind to get into the water that others are going to drink.

**We have learned that :**

1. Food builds up the body and repairs it as it wears out.
2. Food is the fuel of the body and keeps it warm.
3. Food gives us power to work.
4. We must eat different kinds of food.
5. There are only four kinds of food.
6. Proteids build up and repair the tissues of the body.
7. Starch, sugar, and fat produce heat and power to work.
8. Mineral food is needed to make bone.
9. The body needs water.
10. Water often contains germs of disease.

## CHAPTER V

### DIFFERENT ARTICLES OF FOOD

**The perfect food.**—Milk is a perfect food for young children. It is both food and drink for them. Milk consists of water, proteid, fat, sugar, and salts. The fat, when separated by churning, is called butter. What is left of the milk is called buttermilk. It contains all of the milk except the fat, and is a useful food. The fat and the proteid together can be separated from the rest and made into cheese; the water, sugar, and salts that are left behind are called whey.

Milk must be pure to be healthful. Great care should be taken to keep it clean. The stables, cows, and those who do the milking should be strictly clean; and all vessels in which milk is put should first be thoroughly washed with boiling water. Milk should not be kept in a damp, mouldy cellar, but in a clean, dry, well-aired place.

**Animal food.**—Almost all animal food is more readily digested than vegetable food. Milk, "the perfect food," is an animal food. Eggs, though hardly a perfect food—having too little sugar—are valuable articles of diet, for they consist of proteid, fat, and

some mineral matter. Usually they are easily digested if they are soft-boiled, poached, or made into custards.

Meat consists of water, proteid, fat, and some salts. Beef, lamb, chicken and turkey are the most digestible forms of meat. Fresh fish also is easily digested, and forms another valuable article of diet.

**Vegetable food.**—Such cereals as wheat, rice, barley, oats and rye consist of starch, proteids, water, salts, and fat. The most important article of food made from cereals is bread. In this country bread is usually made from wheat. If the proteid part of the wheat is left in the flour it will have a brown color. Bread made from this flour is more nutritious but less easily digested than bread made from white flour.

Potatoes consist largely of water and starch. They are usually eaten with cream, butter, or gravy and meat, and in this way a supply of starch, fat, and protein is obtained. Green peas, string beans, spinach, and asparagus are examples of other vegetables that are easily digested. Such vegetables are useful chiefly for the salts they contain.

Ripe, sound, fresh fruits are of some value as food, because of the sugar and salts in them. Fruit salts are especially good for growing children.

**Food not easily digested.**—Some articles of food are more easily digested and more nutritious than others. People have to learn by experience what agrees with them, and, if they are wise, they will not eat food that disagrees with them.

Pork of any kind, salt meats, salt fish, veal, liver, kidney, goose, and duck are hard to digest.

Green corn, radishes, raw celery, onions, tomatoes, carrots, and cucumbers are not easily digested, and contain only a small amount of nourishment.

Hot bread, buns, rolls, and cake are hard to digest. Pies, tarts, pastry, nuts, and salads are not easily digested.

Unripe or partially decayed fruits should never be eaten. Dried, canned, and preserved fruits, and jellies are not so desirable as fresh ripe fruit.

**The cooking of food.**—Most of our food is cooked in some way, in order to make it pleasanter to the taste, or easier to digest. After having been cooked, meat is more tender, and more digestible. Only a small amount of uncooked starch can be digested, but after starchy food has been well cooked the starch grains swell and burst their envelopes, and can then be easily digested.

Care is needed in the cooking and serving of food. Every dish or utensil in which it is cooked,



THE COOKING OF FOOD.

and every dish in which it is served or put away, should be thoroughly clean. Food should be kept covered as much as possible, to protect it from insects.

Every one should learn to cook. Such knowledge is always useful, and often necessary.

**Artificial drinks.**—Water is often flavored in different ways to make artificial drinks. All artificial drinks may be divided into two classes, those which contain alcohol, and those which do not.

Among those which do not contain alcohol are tea, coffee, cocoa, and chocolate. These drinks are

taken mainly because of their pleasant taste and the agreeable effects they produce. Cocoa and chocolate are more nourishing than either tea or coffee, and if prepared with plenty of milk may be given to children. Tea and coffee are not good drinks for children, and grown people are injured by taking them too strong, or in too large a quantity.

**Rules.**—A few simple rules in regard to eating should always be observed.

1. We should eat slowly and chew our food well.
2. Food should not be eaten after the feeling of hunger is satisfied.
3. Meals should be taken at regular hours.
4. Nothing should be eaten between meals.
5. The evening meal should be the simplest and plainest meal of the day.
6. No drink should be taken while there is food in the mouth.
7. Ice water should not be taken freely at meal time.

**Alcohol.**—In our choice of what we eat and drink we should select what will keep the body in as nearly perfect condition as possible, and avoid what will prevent us from doing our best work. The use of

alcoholic liquor unfits a man for careful and exact work, and for holding positions in which he has charge of the life and property of others. Many companies and business firms will not employ a man who is known to drink, because they are afraid to trust their business to him. The following show that this statement is true:

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY,  
PITTSBURG, PA.

*January 15, 1900.*

*Gentlemen:*—Replying to yours of the 13th instant, we do not post or publish any rules concerning the use of alcoholic liquors by our employees, nor do we consider such rules at all necessary. We do not knowingly employ for any important position any person known to be a habitual user of alcoholic liquors. If we, unfortunately, find such a person in our employ, we dismiss him.

Yours truly,

B. H. WARREN,

*Second Vice-President.*

NEW YORK CENTRAL & HUDSON RIVER R. R. Co.

“The use of intoxicating drink on the road or about the premises of the corporation is strictly forbidden. No one will be employed, or continued in employment, who is known to be in the habit of drinking intoxicating liquor.”

E. VAN ETEN,

*General Superintendent.*

## ILLINOIS CENTRAL RAILROAD COMPANY.

"The Company hereby announces that in employment and promotions in its service a preference will be given to persons who are known to be total abstainers; and under no circumstances will it tolerate acts of drinking by men on duty, or wearing any part of the Company's uniform."

A. W. SULLIVAN,

*General Superintendent.*

## METROPOLITAN STREET RAILWAY COMPANY, NEW YORK.

"Drinking any beer, wine, liquor or intoxicating drink, or entering any drinking place during the hours of duty, or the carrying of any intoxicating drink about the person, or the bringing of same on the premises of the Company will be cause for discharge.

The frequenting of drinking places, or the indulgence to excess in intoxicating liquors when off duty, will be cause for discharge."

OREN ROOT, JR.,

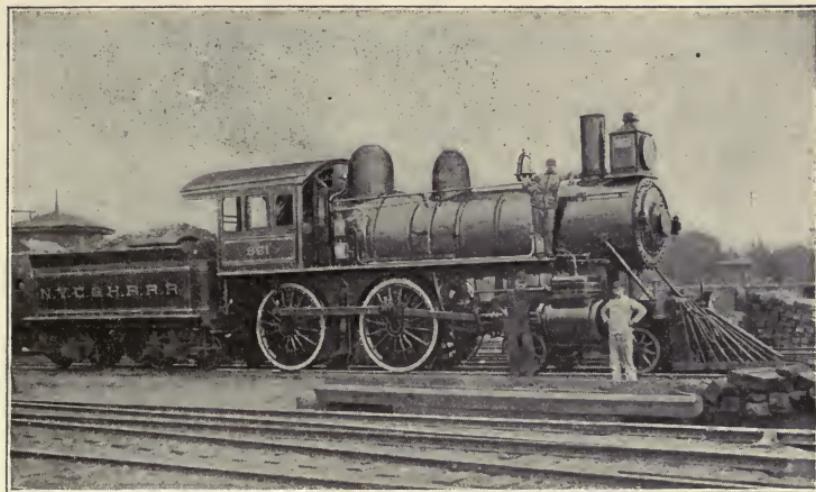
*Assistant to the President.*

## CANADIAN PACIFIC RAILWAY COMPANY.

"In the interests of safety and efficiency, the use of intoxicants while on duty is absolutely prohibited. No instance of intoxication on duty will ever be overlooked, but will be followed by immediate dismissal. The habitual use of intoxicating liquors will be considered sufficient cause for dismissal, and preference will in every case be given to those who abstain from their use."

J. W. LEONARD,

*General Superintendent.*



MEN WHO HAVE CHARGE OF THE LIVES OF OTHERS.

#### AMERICAN EXPRESS COMPANY.

“Any employee drinking liquor while on duty, or during business hours, will be cautioned once, and if he repeats the offence, be discharged immediately. Any employee who is known to drink to excess, while off duty, will be dismissed from the service.”

JAS. C. FARGO,  
*President.*

#### We have learned that :

1. Milk is a perfect food.
2. Meat contains proteids, fat, salts, and water.
3. Cereals contain water, salts, starch, and proteids.
4. Vegetables are useful chiefly for the salts they contain.
5. Some articles of food are not easily digested.

## CHAPTER VI

### HOW OUR FOOD IS CHANGED INTO BLOOD

**Digestion.**—The leather that is used to make your shoes was once the skin of an ox or a calf; the yarn of which your winter stockings are made was once growing as wool on the back of a sheep; the cotton that is used to make thread and cloth was once growing in the fields of the sunny South. Before skin, wool, and cotton can be used to make or repair our clothing they have to be changed, and this changing is done in buildings which we call factories.

The soft, fluffy cotton carried into a factory is changed to a piece of cloth; the wool is changed into yarn, and the skin of the ox or the calf is changed into leather.

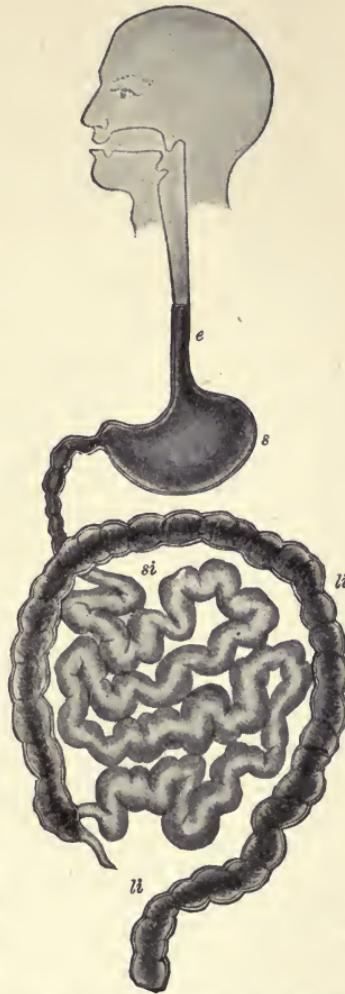
Just so, everything you eat must be changed before it can be used to build up or repair the body; it must be changed into blood; and the first steps of this process of changing are called digestion.

The factory in which digestion is carried on is a long tube which passes through the body. In it there are three main workshops, the mouth, the stomach, and the intestine.

The process of digestion begins in the mouth, where our sharp front teeth cut off pieces of food; our broad back teeth grind the food up; and the tongue rolls it around so that it may be well chewed and mixed with saliva.

**The teeth.**—The teeth are made of material which resembles bone. Every tooth has a crown, which is the part you can see in the mouth, and a root or roots which fit into holes in the jaw. If you crack a tooth with a hammer you will find in the centre a little hollow for small nerves and blood tubes.

The crown of each tooth is covered with a thin layer of enamel, the hardest material in the body. If a part of the enamel is broken off, the tooth will decay and a hole will be



THE LONG TUBE WHICH PASSES THROUGH THE BODY.

*e*, the esophagus.

*s*, the stomach.

*si*, the small intestine.

*li*, the large intestine.

formed. This becomes larger and larger until a nerve is reached, and then the tooth may ache.

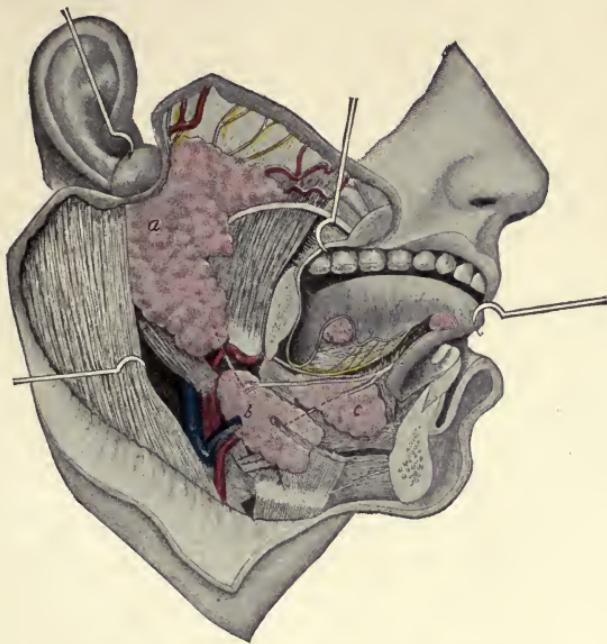
We have during our lifetime two sets of teeth.



A SECTION  
OF A TOOTH,  
SHOWING  
ENAMEL,  
CROWN, CAV-  
ITY AND  
ROOTS.

The first teeth begin to come when we are about seven months old. They are quite small, and are sometimes called milk-teeth. There are only twenty of them. When a child is about six years old the roots of the milk-teeth waste away, and new teeth, which have been formed at the roots of the old ones, push through the gums and force the roots. old teeth out. These second teeth are larger than the milk-teeth. There are thirty-two of them in all, but four of them do not appear until we are grown up, and for this reason they are called wisdom-teeth.

You should take great care of your teeth to prevent them from decaying. They should be cleaned with a soft brush, warm water, and a little tooth-soap, or tooth-powder, free from grit. Particles of food should not be allowed to remain between the teeth, but should be removed after leaving the table. They should not, however, be removed with a pin or anything hard, but with a bit of silk or a piece of soft wood. You should not crack nuts with your teeth, or bite anything very hard, because, in that way, the



THE SALIVARY GLANDS, *a*, *b*, AND *c*.

enamel may be injured and the teeth may soon decay.

**The saliva.**—If you put a piece of dry bread into your mouth and chew it, the bread soon becomes moist and easy to swallow. It is moistened by a watery fluid, called saliva, which is made in small organs, called salivary glands.

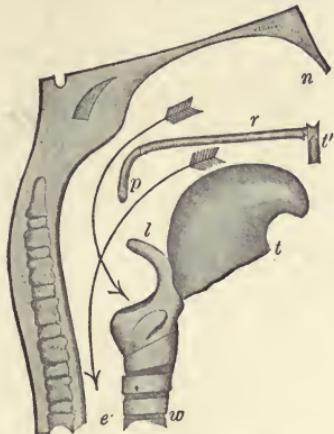
Glands are clusters of cells which are held together by connective tissue and are surrounded by small blood tubes. These cells take certain materials out

of the blood into themselves and change them into new fluids, which are poured out as they are needed. Thus, in the salivary glands, saliva is made from material taken from the blood. Besides the salivary glands, there are other glands in other parts of the body.

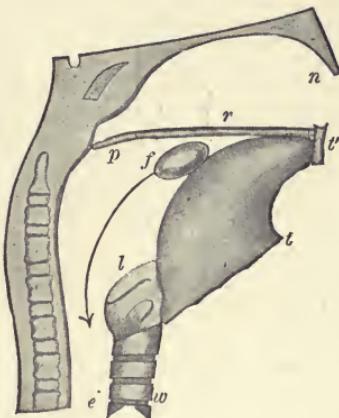
From the salivary glands the saliva flows into the mouth through small tubes. When you have nothing in your mouth, the salivary glands work slowly, and only enough saliva is made to keep the mouth moist. But the moment you begin to eat, or chew anything, they begin to work faster and pour saliva into the mouth more rapidly. Even the sight or thought of pleasant food will often increase the flow of saliva, and, as we say, "make the mouth water."

Saliva has the power to change starch into a kind of sugar. This is very important, because sugar will dissolve in water, but starch will not. If you put some sugar into a cup of water, it will dissolve quickly. Stir the water for a minute or two, then pour it off, and you will find no sugar left in the cup. If you now crumble a small piece of bread, which consists largely of starch, and put the crumbs into a cup of water, they will not dissolve. When you pour off the water the bread crumbs will remain at the bottom of the cup.

The starch in our food must be changed to sugar so that it will dissolve, because it cannot make blood until it is dissolved. We ought, therefore, to eat slowly and chew our food well, so that the starch in it may be well mixed with the saliva, which changes it to sugar.



THE PARTS OF THE MOUTH IN BREATHING.



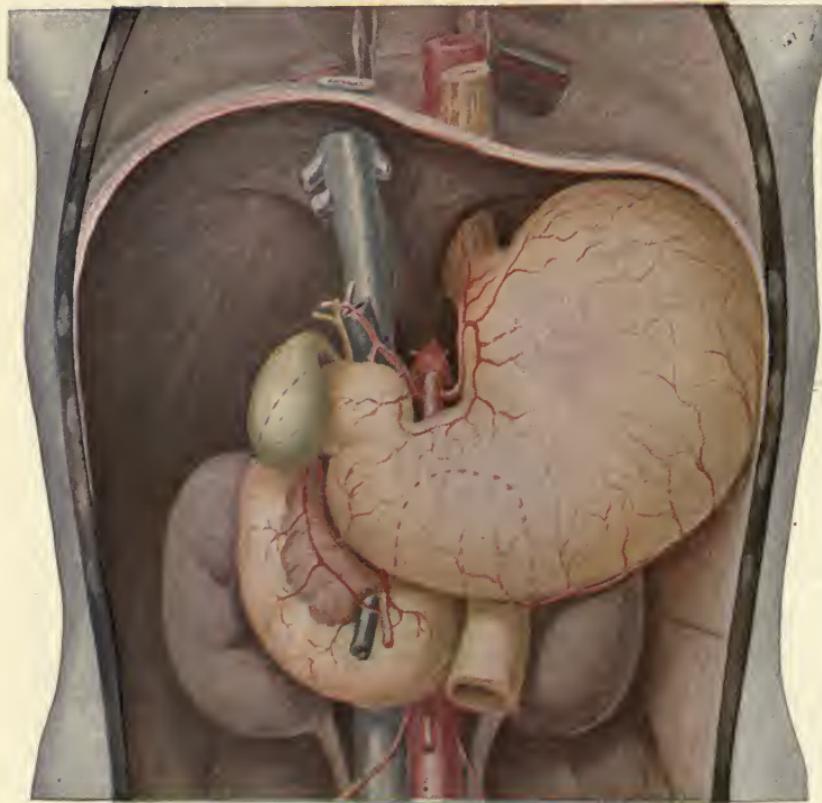
THE SAME PARTS IN SWALLOWING.

*n*, the nasal cavity ; *r*, roof of the mouth ; *p*, soft palate ; *l*, lid over opening into windpipe ; *w*, windpipe ; *e*, esophagus ; *t*, tongue ; *v*, tooth ; *f*, food that is being swallowed.  
(Landois and Stirling.)

The chewing of tobacco not only wastes saliva, but is an unclean habit. Smoking, too, wastes saliva.

**Swallowing.**—After the food has been torn to pieces by the teeth and moistened by the saliva, the soft, wet mass is pushed back into the throat by the tongue, and then passes through a tube, called the esophagus, into the stomach.

The wall of the esophagus contains muscles. When food passes into this tube from the mouth these



STOMACH IN ITS NATURAL POSITION.

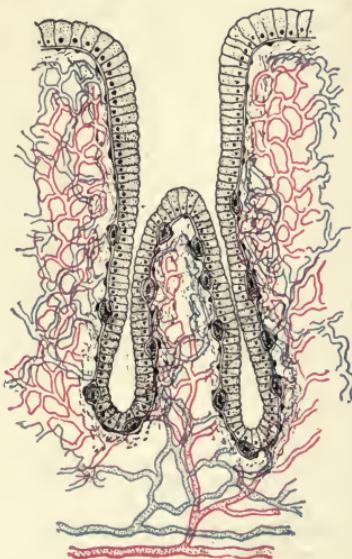
(See Appendix for Key.)

muscles contract and force the food along until it reaches the stomach.

Before the food can pass down the esophagus it has to pass over the opening into the windpipe. Some of the food might get into the windpipe if it were not for a lid which shuts down and covers the small opening whenever we attempt to swallow. Just as soon as the food has passed the opening, the lid lifts up and allows air to go down again into the lungs.

Sometimes a crumb, or a drop of water, goes the wrong way and slips under this lid into the windpipe. We then cough violently to get it up. If a large piece of food were to get into the windpipe we should die unless it were quickly taken out, for we could not breathe.

**Digestion in the stomach.**—The stomach looks like a bag or pouch. Its walls are made of muscle, and have a soft lining like velvet. The stomach, then, is a muscular sac with a soft lining. It lies in the upper part of the abdomen, largely to the left side and below the heart. Its size varies



A GASTRIC GLAND. (Magnified.)

in different individuals. Its length, when fully distended with food, is about ten or eleven inches, and its diameter is from four to five inches.

The stomach has an opening at its upper end, where food comes into it from the esophagus, and another opening at its lower end, where food goes out into the intestine.

After food comes into the stomach it is mixed with a juice called gastric juice. Gastric is a word meaning "of the stomach," so gastric juice simply means juice of the stomach. The whole of the soft lining of the stomach is full of little glands which make this juice. On page 67 there is a sketch of one of these glands. It is made much larger than the glands really are, that you may see what they are like. When no food is in the stomach the glands are at rest, but when food comes in they begin to make gastric juice at once, and pour it out into the stomach.

Gastric juice has the power to dissolve the proteid part of our food, such as lean meat, white of egg, and part of milk and vegetables. It cannot dissolve starch or fat, and it stops the action of saliva.

Soon after food has been swallowed, the muscles at one end of the stomach contract, making that end smaller. This forces the food to the other end. Then

the muscles at that end contract, while the first ones relax, and the food is forced back again. As the food is kept moving from one end of the stomach to the other, it is mixed with the gastric juice, and the mixing goes on until this juice has completed its work.

The food, however, does not all remain in the stomach until digestion there is finished. As soon as any part of it is ready, it is squeezed out through the lower opening into the intestine.

A small part of the food is absorbed into the blood directly from the stomach without passing into the intestine. It soaks through the soft lining of the stomach into the blood tubes in its walls, and so becomes a part of the blood stream.

**Digestion in the intestine.**—The intestine is a tube which extends downward from the stomach. The upper part is small in diameter and is called the small intestine. The lower part, which is a continuation of the small intestine, is larger in diameter, and is called the large intestine. The small and the large intestine together are about twenty-five or thirty feet long, and are nicely folded up in the abdomen so as to take up very little room. The wall of the intestine is made up largely of muscle, and has a soft lining like

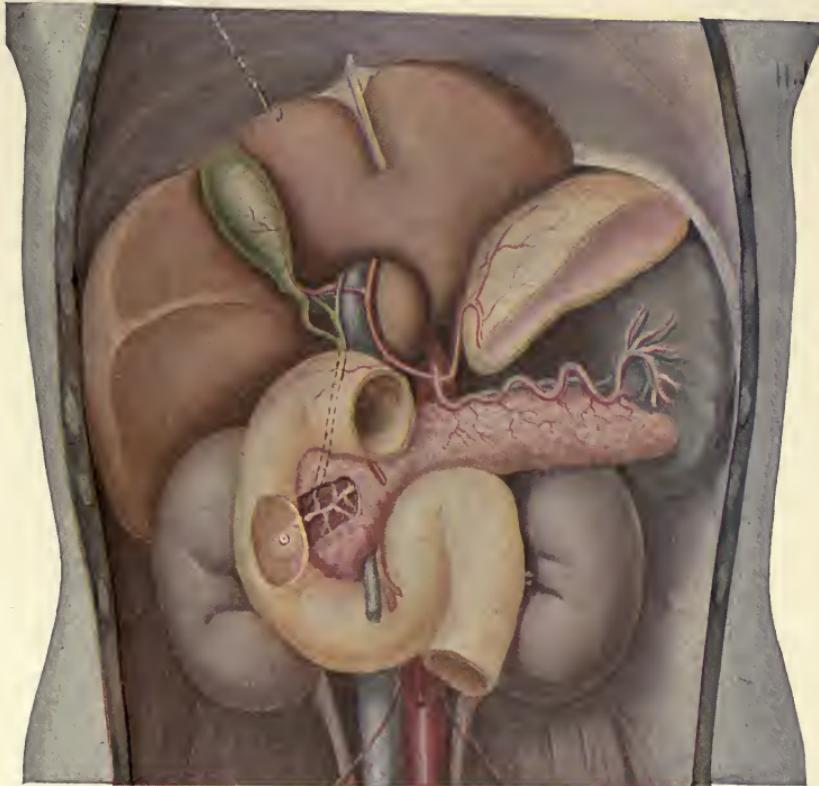
the lining of the stomach. Digestion in the intestine takes place mainly in the small intestine.

In the mouth, part of the food is changed by a fluid, the saliva. In the stomach, another part of the food is changed by a fluid, the gastric juice. In the small intestine, food is changed by three fluids. One of these, the pancreatic juice, is made by the pancreas; another, the bile, is made by the liver; and the third, the intestinal juice, is made in the wall of the intestine.

The pancreas, or sweetbread, is a gland which lies behind the stomach. It makes the most wonderful fluid of all, the pancreatic juice. The pancreatic juice can do what saliva does, for it can change starch to sugar. It can do what gastric juice does, for it can digest proteids. And it can do what neither saliva nor gastric juice can do,—it can digest fat.

The liver is the largest gland in the body. It lies in the upper part of the abdomen, on the right side, and close to the lower ribs. It is made up of liver cells and blood tubes, held together by connective tissue. These cells take from the blood certain material, and with it make a bitter fluid, called bile. The liver is making bile all the time, but this fluid passes into the intestine only when digestion is going on. When digestion is not going on, the bile is stored in a little

pear-shaped bag, the gall bladder, which is tucked away under the liver. The bile does not, by itself,



THE LIVER AND PANCREAS.

(See Appendix for Key.)

digest food, but it helps the pancreatic juice to do so.

The intestinal juice is made by small glands in the soft lining of the intestine. Its power to digest food

is very slight. Its most important use is to assist in the digestion of starch and cane sugar.

When the food enters the small intestine from the stomach much of it is still undigested. It then meets the bile and the pancreatic juice. These fluids, coming from the pancreas and the liver, enter the intestine by a small tube near the place where the food enters from the stomach. The muscles in the wall of the intestine contract and force the food along in the intestine, so that it becomes mixed with the pancreatic juice, the bile, and the intestinal juice.

By the combined action of these juices any starch that escaped digestion in the mouth is changed to sugar, any proteid that escaped digestion in the stomach is digested, and the fats upon which the saliva and gastric juice have no power are also digested. Water is not digested, for it does not require to be changed, and salt is dissolved but not changed.

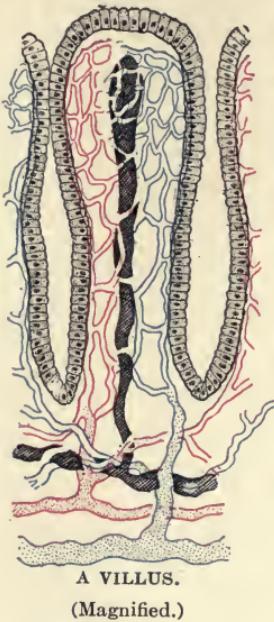
As a result of the changes brought about by digestion, the food which was swallowed as bread, butter, meat, potatoes, milk, water, salt, and so on, becomes a milk-like liquid in the intestine. The nourishing part of the food contained in this milk-like liquid is now ready to be taken into the blood tubes and become blood.

**How food is taken into blood tubes.**—You will remember that the intestine has a lining which is soft like velvet. The surface of this soft lining in the small intestine has little tongue-like projections. One of these little projections is called a villus, while villi is the name given to more than one. There are about four million villi in the small intestine, but there are none in the large one.

In each of these villi there are very small blood tubes, and also one or more little tubes called lacteals. The word lacteal means like milk, and this name is given to the tubes because they contain a fluid which looks like milk.

As food is digested in the intestine it soaks, or oozes, through the walls of the villi. The proteids, sugar, and mineral part of the food then pass on through the walls of the little blood tubes, mix with the blood, and go with it from these little tubes into larger ones called veins.

The digested fats do not pass through the walls of the little blood tubes of the villi, but go through the walls of the lacteals. In the lacteals the digested fats have the appearance of a milky fluid. The lacteals pass through a number of tiny glands, and unite again and again to form larger tubes. These



A VILLUS.  
(Magnified.)

larger tubes finally unite to make one tube about the size of a goose quill, or a small lead pencil, and this pours its contents into a large vein to mix with the blood.

**Alcohol.**—Alcohol makes the small blood tubes in the lining of the stomach larger, and they then contain a greater amount of blood than usual. This gives a reddish appearance to the lining of the stomach, just as a mustard plaster will cause a reddish appearance of the skin. If only a small amount

of alcohol is taken, the blood tubes are enlarged for a short time, and then return to their usual size.

The chief danger in drinking a small amount of alcoholic liquor occasionally is not in an immediate injury to the stomach, or any other organ, but in the fact that this drinking of small amounts leads so often to the drinking of larger amounts which are harmful, and to the forming of a habit of drinking which cannot be given up, even when a man knows that alcoholic liquor is injuring him. It is easy to see, therefore, that the only safe plan is not to drink alcoholic liquors.

If alcoholic liquor is taken frequently, even in moderate quantities, the blood tubes in the lining of the stomach are kept large, and thus the lining continues to be inflamed. The gastric juice is less able to do its work, and digestion in the stomach requires more time than it should.

When large amounts of alcohol are taken for a length of time the extreme inflammation of the lining of the stomach causes a serious disease, and in the end it may become impossible for the stomach to retain and digest food.

The large amount of liquid that is often taken by beer drinkers stretches the wall of the stomach and greatly increases its size. This stretching weakens the muscles in the wall of the stomach, so that food is not forced on into the intestine so promptly as it should be. This is a frequent cause of painful indigestion.

**Effect of alcohol on the liver.**—When alcohol is swallowed it quickly soaks through the soft lining of the stomach into the blood tubes in its wall, and then goes with the blood to the liver. The liver is, therefore, the first organ to receive the alcohol after it enters the blood.

Alcohol is particularly injurious to the cells of the liver, and is the chief cause of a disease of the liver

which often proves fatal. In this disease the liver becomes larger than it should be. It may afterwards partly waste away and have a shriveled, hardened appearance. It is then commonly called a "hob-nailed liver."

**Effect of tobacco on digestion.**—The continued use of tobacco, especially if much is used, often interferes with digestion. When it is used by young persons it tends to hinder growth, because it prevents the proper nourishing of the body.

Jay W. Seaver, M.D., Director of the Yale University gymnasium, proved that the use of tobacco has this effect. At different times, he made measurements of students to learn how much they had grown, and he found that the average growth of those who did not use tobacco was considerably greater than the average growth of those who did use it.

**We have learned that :**

1. Food must be changed into blood before the body can use it.
2. This change begins in the mouth, and is completed in the stomach and the intestine.
3. In the mouth, food is chewed and mixed with saliva.
4. Our teeth cut and grind the food into small pieces.
5. Saliva moistens the food, and changes starch to a kind of sugar.
6. From the mouth, food passes through the esophagus to the stomach
7. A little lid keeps food from getting into the windpipe.

8. In the stomach, food is changed by gastric juice.
9. Gastric juice can dissolve proteid food.
10. In the intestine, food is changed by bile, pancreatic juice, and intestinal juice.
11. Bile assists the pancreatic juice, which can dissolve starch, proteid and fat.
12. Bile is made in the liver, and pancreatic juice in the pancreas.
13. When food is digested, it is taken up by little veins and other small tubes, called lacteals, in the wall of the intestine, and mixed with the blood.

## CHAPTER VII

### HOW THE BLOOD BUILDS UP THE BODY

**The blood carries food for the body.**—After leather, yarn, and cloth are manufactured they are not stored away and locked up in factories, but are sent out over the country by railroads, canals, and rivers to cities, towns, and villages, so that the people who need them can find and use them.

In the same way, after our food is manufactured into blood it does not remain in the factory, but is sent out to all parts of the body, so that it can be used in building them up and repairing them.

Instead of railroads, canals, and rivers we have running through our bodies a system of little tubes; and instead of railroad trains and canal boats we have the warm, red blood flowing through these tubes, loaded with material the body needs to build it up. In your chest is the heart, a muscular pump, which works without ceasing day and night as long as you live, and forces the blood through all of the blood tubes, even to the very tips of your fingers and toes.

**The arteries.**—There is a large blood tube, the

aorta, into which blood comes out from the heart. You know how branches are given off from the trunk and larger limbs of a tree. The aorta also gives off



HEART AND AORTA.

*a*, Branches of Aorta.

branches almost at its very beginning, and all along its course. Each of these branches divides again and again into smaller ones, and the name arteries is given to the aorta and its larger branches, through which

the blood flows out from the heart to all parts of the body.

**The capillaries.**—This dividing of the arteries goes on until the little blood tubes are so small that you cannot see them, and they are then called capillaries. There are so many of these capillaries, and they lie so closely together that you cannot put the point of a needle between them. If you pierce your skin with a needle, its point will pass through one or more tiny capillaries and allow the blood to flow from them.

**The veins.**—After flowing through the capillaries, the blood commences to return to the heart, and the tubes through which it returns are called veins. You have seen little rills on a hillside unite to make a larger stream, and you know that larger streams unite to make one still larger, until a great river is formed. In a similar way, these tiny capillaries unite to make small veins, and these small veins unite to make larger ones, until all the veins from the lower part of the body have joined to form one large vein through which the blood flows back to the heart. All the capillaries and veins of the upper part of the body unite in the same way to form another large vein through which the blood flows back to the heart.

You have only one body; but different parts of it,

such as the head, the arms, the hands, have different names. There is only one set of blood tubes, but one part of it is called arteries, another part capillaries, and a third part veins.

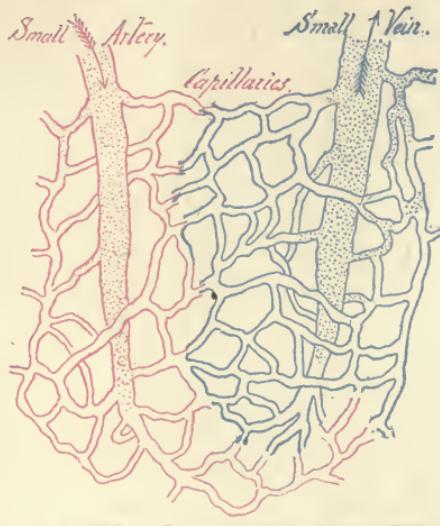
If you start at one point in a circle and follow the circumference you will come round to the point from which you started. The blood starts from the heart, goes through the body, and comes back to the heart very much as if it were moving in a circle. For this reason it is said to circulate through the body.

**What takes place in the capillaries.**—The walls of the capillaries are very thin, thinner than the thinnest paper you ever saw. While the blood is flowing through the capillaries, the food in the blood oozes through the walls of the capillaries and feeds the tissues around them.

Oxygen is one of the gases of which air is composed. As the blood flows through the lungs it gets oxygen from the air we breathe. This oxygen is carried by the blood to all parts of the body, and afterwards goes out through the walls of the capillaries to the tissues, just as food passes out to the tissues. While these are going out from the blood, waste matter, made by the using up of the food and the wearing out of the tissues, comes into

the blood from the tissues, through the walls of the capillaries.

This exchange between the blood and the tissues takes place only in the capillaries and not in the



ARTERY, CAPILLARIES, AND VEIN.  
(Magnified.)

arteries or veins. The walls of the arteries and veins are too thick to let the food and oxygen go out or the waste matter come in. In the arteries the blood simply flows out to the capillaries from the heart, and in the veins it simply flows back from the capillaries to the heart.

You have now learned three things which the blood does as it circulates through the body. It brings

food to the tissues, it brings oxygen to the tissues, and it carries away matter that is worn out and useless.

**What the blood is like.**—When the blood flows from a cut in your finger it appears to be simply a red fluid, but it does not long remain fluid. It soon becomes sticky, and in a few minutes thickens into a mass which resembles jelly. This jelly-like mass is called a clot.

It is a good thing for us that blood clots, for if it did not it would be difficult, or impossible, to stop bleeding, even from a small cut or wound. The clot is nature's plug to stop bleeding.



RED AND WHITE CORPUSCLES.

(Magnified.)

**The blood corpuscles.**—If you should look at a drop of blood under a microscope you would see a large number of tiny bodies, called corpuscles, floating about. These corpuscles float in a watery fluid and are so small that they cannot be seen without the microscope. They are of two kinds, red and white.

**The red corpuscles.**—The red corpuscles are tiny disks, flat, soft, and round, and are of great use to us, although they are so very small. The real business of

these little things is to carry oxygen, which they get in the lungs from the air we breathe. They float along in the blood stream, and, as they are passing through the capillaries, oxygen escapes from them and goes through the walls of the capillaries to the tissues.

**Color of the blood.**—The color of the blood is due to its red corpuscles. If these were taken out the remaining part of the blood would be colorless, and would look like water. The red corpuscles change from a dark bluish-red to a bright red color when they take in oxygen in the lungs. When the red corpuscles lose oxygen in the capillaries their color changes from a bright red to a dark bluish-red. It is for this reason that the blood has a bright red color in the arteries and a dark bluish-red color in the veins.

**The white corpuscles.**—The white corpuscles are slightly larger than the red ones, and are fewer in number. A drop of blood has about five hundred red corpuscles for each white one.

The white corpuscles are made up of a very soft, jelly-like substance, and they can readily change their shape. At one time a white corpuscle may be quite round. At another time part of the corpuscle may be pushed out so as to resemble a tiny arm, and a corpuscle may have more than one of these little arms

at the same time. A small arm is able to encircle little solid particles that have found their way into the blood and are injuring our health. Such particles may thus be enclosed in the body of a white corpuscle and be destroyed.

In this way white corpuscles protect our bodies from germs of disease. When disease germs, or bacteria, enter the body through a wound, or in any other way, white corpuscles fight them and try to destroy them. Sometimes, when the bacteria are very strong, the battle becomes so fierce that many white corpuscles are killed. The dead bodies of these corpuscles then form what we call matter, or pus.

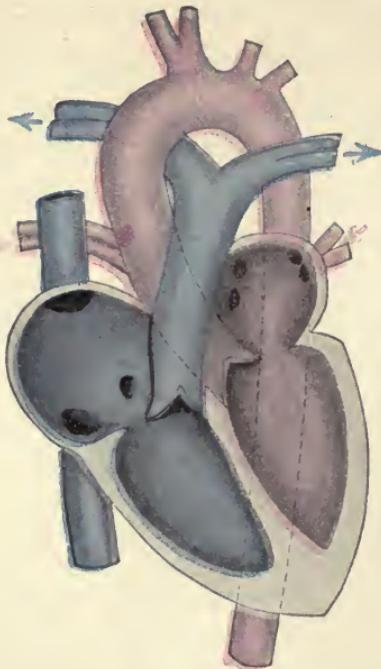
It is believed also that the white corpuscles aid, in some way, in the clotting of blood.

**The heart.**—Many of you have seen a sheep's heart. It is a good deal like a human heart. The heart is made of muscle. If you cut a sheep's heart open you will see that it is not solid muscle, but within it are hollow places, called cavities. You will also see how thick and strong the walls of these cavities are.

The human heart is about the size of a man's fist. A partition down the middle of it divides it into a right side and a left side. This partition wall is so tight and strong that the blood in one side cannot get

through into the other side. Each side is divided into an upper cavity and a lower cavity.

**How the heart works.**—If you take in your hand a small rubber ball that has a hole in it, squeeze the



SECTION OF HEART, SHOWING THE FOUR CAVITIES.

air out of it, and then hold it in a basin of water, the ball will fill with water as soon as you open your hand. If you now close your hand tightly upon the ball you will force the water out through the hole. If you open and close your hand slowly several times, you

will see that each time you open your hand the ball fills with water, and each time you close your hand the water is forced out.

The four cavities of the heart are filled and emptied in a somewhat similar way. The muscles of which the walls of the heart are composed contract and relax. When they relax they open the cavities, and blood runs in from the veins. When these muscles contract they close the cavities, and blood is squeezed out into the arteries. Both sides of the heart, the right side and the left side, open at the same time and close at the same time.

The closing of the right side forces dark bluish-red blood into and through the lungs, and on into the left side of the heart. While going through the lungs this dark blood, just in a twinkling, receives oxygen from the air, and is changed to a bright red color.

The left side closes with great power. Its closing sends the bright red blood rushing out through the large artery, the aorta, on through the small arteries, through the tiny capillaries, through the little veins, and back through the large veins into the right side of the heart.

The heart, then, is like two little pumps fastened together. The right side forces the dark blood through

the lungs ; the left side, which is stronger, forces the bright red blood through the body.

**The beat of the heart.**—The heart lies against the chest wall just behind the ribs. The small end of it points downwards, and a little towards the left side of the body. As the heart contracts suddenly and with great force it jars the chest wall. Each contraction of the heart is called a beat. When the heart is beating slowly and quietly it may not be easy to feel the jar. But active exercise, such as running, causes the heart to beat faster and stronger, and then the jar is easily felt each time the heart beats.

**The pulse.**—The pulse is caused by the beating of the heart. It can be felt in all the arteries, but not in the capillaries or veins. A doctor usually feels your pulse at the wrist because there the artery is near the surface. In health the heart beats, on an average, about seventy-two times a minute ; but during fever it beats faster, and so the doctor counts the pulse beats to help him find out the condition of your heart.

**Health of the heart.**—What a wonderful little worker the heart is ! Day and night, summer and winter, year after year, it beats on and on, never taking a holiday. If yours should stop beating for just one short minute you would die.

Without a sound, strong heart you can never be perfectly healthy. Some diseases that are often caused by dampness and by wearing wet clothing are liable to injure the heart. For this reason every one should remember these short rules:

Never sit on wet grass or damp ground.

Never sleep in a damp bed or in a bedroom with damp walls.

Whenever your clothing gets wet put on dry clothing as soon as you can.

Do not live in a house with a damp cellar or with damp walls.

Keep your feet dry and warm.

**How the circulation may be affected.**—The circulation of the blood may be hindered in many ways. Large veins lie just under the skin and near the surface. Tight clothing prevents the blood from flowing freely and easily through these veins. Tight boots make cold feet because they prevent the free flow of the blood. Tight garters, also, are a frequent cause of cold feet. The heart needs plenty of room in order to work well. Tight waists and other tight clothing press in the soft walls of the chest and interfere with the heart.

Exercise makes the blood circulate well. A brisk

walk brings a warm glow to the skin. A game of ball or blind man's buff will quicken the circulation and warm up the body. Such exercise will help to make you healthy and strong.

A daily bath will aid the circulation, if it is followed by brisk rubbing with a coarse towel till a warm glow is felt in the skin.

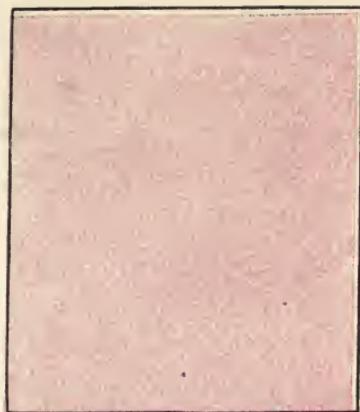
**Effect of alcohol on the heart.**—The first effect of alcohol on the heart is to make it beat faster than usual, but after a short time the heart will beat more slowly than it did before the alcohol was taken. If, however, a very large amount is taken, as is sometimes done on a wager, it may stop the beating of the heart almost immediately, and cause death.

Some alcoholic liquors, such as wine and beer, have a tendency to produce too much fat. A great deal of fat often forms on the surface of the heart and between the fibres of its muscles, so that the heart becomes weaker than it was. This diseased condition is called fatty heart.

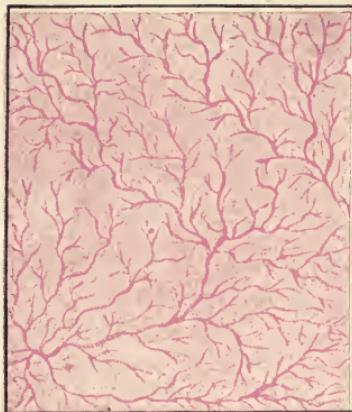
**Effect of alcohol on the circulation.**—The walls of the arteries contain involuntary muscles. When these muscles contract the arteries become smaller and will hold less blood; when these muscles relax the arteries become larger and will hold more blood.

Nerves ending in these muscles cause them to contract and relax.

Alcohol weakens the nerves which control the muscles of the arteries, and then the muscles relax. Thus



APPEARANCE OF ARTERIES IN LINING OF HEALTHY STOMACH.



APPEARANCE OF ARTERIES EN-LARGED BY ALCOHOL.

alcohol causes the small arteries throughout the body to become enlarged and to hold more blood than usual. A well-known illustration of this is the flush of the face that follows the drinking of alcoholic liquor.

The continued use of alcoholic liquor, especially of beer, tends to the forming of fat in the walls of the arteries. This fat weakens the arteries and makes them less able to bear the pressure of the blood as it is forced through them by the heart. Any sudden strain

on the wall of an artery may then cause a break, which may produce death.

**Effect of alcohol on the blood.**—Besides its effect on the heart and on the arteries, alcohol affects also the blood itself. It acts upon the red corpuscles of the blood and lessens their power to take up oxygen and give it out to the tissues. In this way every organ of the body is affected by alcohol in the blood, for every part of the body needs oxygen and depends chiefly upon the blood for its supply.

**Effect of tobacco on the heart.**—The use of tobacco often causes the heart to beat irregularly, because tobacco contains a deadly poison called nicotine, which acts upon the nerves that control the beating of the heart. Physicians use the name "tobacco heart" in speaking of a heart which has been injured by nicotine. In the mildest form of this disease there is a slight fluttering of the heart and an uncomfortable feeling in the left side of the chest. In more severe attacks the heart beats violently and causes great distress.

**We have learned that :**

1. Every part of the body is supplied with blood tubes.
2. The heart forces blood through these tubes.
3. The blood carries food and oxygen to all parts of the body, and brings back waste matter from all parts.

4. The tubes through which blood goes out to all parts from the heart are called arteries.
5. The arteries divide up and become smaller and smaller, until they can be seen only with a microscope, and are then called capillaries.
6. As the blood is going through the capillaries, food and oxygen in the blood go through the walls of the capillaries to the tissues ; and waste matter in the tissues comes through these walls to the blood.
7. The capillaries unite and form larger tubes, called veins, which carry the blood back to the heart.
8. Blood can form a clot and thus stop bleeding from a small wound.
9. Blood consists of a watery fluid and corpuscles floating in it.
10. The red corpuscles give the blood its color.
11. After these corpuscles take in oxygen from the air in the lungs they have a bright red color.
12. After they give up oxygen to the tissues they have a dark bluish-red color.
13. The white corpuscles help to protect our body from disease.
14. The heart is made up of muscle. It contains four cavities, which close when it contracts and open when it relaxes.
15. Blood flows from veins into these cavities when they are open, and is forced out into the arteries when the cavities close.
16. Each time the heart contracts it is said to beat.
17. With each beat there is a throb of the arteries which is called a pulse.
18. The use of alcohol may injure the heart, the arteries, and the blood.
19. The use of tobacco may injure the heart.

## CHAPTER VIII

### DRINKS WHICH CONTAIN ALCOHOL



FERMENTATION IN A GLASS  
OF CIDER.

**Fermentation.**—While apples are ripening, sugar is formed in them. The juice of apples is composed largely of water, in which the sugar is dissolved. When the juice is first pressed out of the apples it contains no alcohol. But unless it is kept cold the sugar in the juice quickly changes into alcohol and a gas, which our fathers called carbonic acid

gas, but which to-day is called carbon dioxide. This gas escapes in little bubbles, which may be seen rising up through the liquid, but the alcohol remains in it.

The process by which sugar is changed into alcohol and carbon dioxide is called fermentation. The sugar may be obtained from the juice of ripe fruits, and from the sap of such plants as the sugar-cane, from the starch of potatoes or of such grains as wheat, corn, rye, and barley.

Fermentation is caused by little plants, called fer-

ments. They are so small that they cannot be seen without the aid of a microscope. These ferments float about in the air and lodge on the skin and stems of apples, grapes, and other fruit.

When the grapes and apples are crushed and pressed, ferments are washed from them with the juice, or fall into it from the air. Having once entered the juice, they grow quickly and increase in number rapidly. While growing they act on the sugar and change it into alcohol and carbon dioxide.

**How malt liquors are made.**—Beer, ale, and porter are made from grain. The grain is moistened and then allowed to sprout. By this means the starch of the grain is changed into sugar. The grain, or malt as it is now called, is then dried and ground, and the sugar is dissolved out with water. This is then boiled with hops, and yeast is added because it contains a ferment. It sets up fermentation, by which the sugar is changed into alcohol and carbon dioxide.

**How distilled liquors are made.**—When water is boiled it passes away as a vapor, called steam. When alcohol is boiled it also passes away as vapor. As the steam, or vapor, of a liquid rises it may be collected. If it is allowed to cool it quickly changes back to a liquid.

When wine is heated the alcohol in it boils and turns to vapor, and part of the water changes to steam at the same time. The two vapors are then collected and allowed to cool. The entire process is called distillation. The liquid into which the vapors cool is called brandy. A pint of brandy contains more alcohol and less water than a pint of wine.

Whisky is made from grain. After the grain has sprouted, and its starch has changed to sugar, water is added and alcohol is formed by fermentation, just as in the making of beer. Then it goes through the process of distillation. The alcohol and water that pass off as vapor are collected and cooled into the liquid called whisky, which, like brandy, is made up mainly of alcohol and water in about equal parts.

Rum is made from the sap of the sugar-cane. The sap is first fermented and then distilled.

**What alcohol is like.**—Alcohol is a colorless, transparent liquid. It looks like water, but it has a sharp, burning taste. It acts very differently from water on the organs and tissues of the body. Water is necessary for life. We should die if we could not get it. Alcohol is not only not necessary, but as a beverage it is injurious to health, and thousands die every year from drinking liquors which contain it.

**Is alcoholic liquor a food?**—We have learned that one use of food is to repair waste and build up the body. It is from food that blood, bone, muscle, nerve, and other parts of the body are made. Alcohol contains none of the material necessary to repair waste or build up the body.

Another use of food is to produce heat and power to work. The food that contains the material necessary for this is carried by the blood to the tissues, and oxygen from the air we breathe is carried by the blood to the tissues at the same time. This food and oxygen unite in the tissues, and produce heat and power to work.

Experiments show that some of the alcohol which is taken into the body unites with oxygen in the tissues. When alcohol unites with oxygen in the tissues some heat is produced. But the alcohol at the same time causes the blood tubes of the skin to become larger, so that more blood than usual flows to the surface of the body, and loses heat by coming near the air. More heat is thus lost from the surface of the body than is produced in the tissues. Therefore the effect of alcohol is to lower the temperature of the body.

When alcohol unites with oxygen in the tissues, some power to work is produced. But the general



ATHLETIC STRENGTH.

taken. The effect of alcohol in lessening the muscular strength of the body is recognized, as we have learned, by athletes, for when they are training for contests they do not use it.

Experiments by means of a weight attached to one of the fingers (see page 40) also show that the muscles are affected by small quantities of alcohol, for it was found that the muscles of the finger could do more work when no alcohol was taken than they

strength of the body is not increased, because the alcohol at the same time injures the tissues. It lessens the power of the blood to carry oxygen, and acts upon the nerves to lessen, or destroy, their control over the muscles. The amount of injury done in this way depends upon the quantity of alcohol

could when even a small amount was taken. Alcohol, therefore, does not produce power to work, for it weakens instead of strengthening the muscles. It does not aid in keeping the body warm, for it increases the loss of heat from the body. And it cannot repair waste or build up the body, for it contains none of the material by which this is done. Alcohol, then, is not a food, in the ordinary sense in which we use that term.

**Poisonous action of alcoholic liquor.**—In some cases where only a small amount of alcoholic liquor is taken, the injury to the tissues is so slight, and its effects pass off so quickly that the harm done is not noticed by the one who takes it. Yet the taking of alcohol even in small amounts is dangerous, for small amounts often create an uncontrollable appetite for larger amounts; and when these are taken the tissues are so seriously injured that the harmful effects do not escape notice. It is well known that alcoholic liquor in large amounts produces a condition of intoxication. The drowsiness, stupor, and loss of consciousness in intoxication are caused by the action of alcohol on the brain. This action is entirely different from that produced by food of any kind, but is quite like the action produced on the brain by a class of sub-

stances called narcotic poisons. In many cases death has followed the drinking of alcoholic liquor.

The papers frequently report cases similar to the following, and a record of them can easily be found in the office of the Board of Health in the city where they occur:

“Sarah Hochman, the three-year-old daughter of Harris Hochman, living at 385 Marion Street, Brooklyn, died last night in St. Mary’s Hospital. The child was admitted to the hospital early in the morning, suffering from alcoholic poisoning. She was in a stupor at the time, in which condition she remained up to the time of her death. The poisoning was the result of the child’s eating blackberries prepared in alcohol.”—*New York Herald, August 3, 1902.*

“Seven-year-old Pietro Gordano died early yesterday morning in Roosevelt Hospital of acute alcoholism. On Sunday evening there was a wedding at his home, 209 West Sixty-fourth Street. Pietro got a seat at the wedding table, and in some way managed to get hold of a quart bottle of Italian wine, a little more than half full, and to drink most of it.”—*New York Sun, January 8, 1902.*

In such cases the poisonous action of the alcohol is plainly shown. In fact, alcoholic poisoning is a medical term used in stating the cause of death.

**Mistaken notions about alcoholic drinks.**—One

reason why alcoholic drinks are used is that people have mistaken notions about their value. The rosy look and the fleshy appearance which they often produce cause some people to think that alcohol is good for the health. But this is not true. For those who are in the habit of taking alcoholic drinks, even in moderate quantities, are more likely to become ill, and are less likely to recover from illness than those who do not drink alcohol at all.

Another mistaken notion in regard to alcoholic drinks is that they must be good because they are made from grain and fruit. People who are influenced by this notion forget that grain and fruit are not always good for food. The grain may become musty and the fruit may decay, the change which has taken place making them entirely unfit for food. The fact that ripe grain and fruit are good for food does not prove that alcohol made from them is good for food. Grain and fruit in their natural state do not contain any alcohol. They must first be changed by fermentation before alcohol can be obtained from them.

Mistaken notions in regard to the power of alcohol to produce muscular strength also influence some persons to use it. It has, however, been proved that men



MUSCULAR STRENGTH.

can do more work without alcoholic liquor than they can when they use it.

Benjamin Franklin, who was one of the greatest Americans of Washington's time, was a printer when he was a young man. In his autobiography he gives an account of his experience as a printer in London. He says, "I drank only water; the other workmen, nearly fifty in number, were great drinkers of beer. On occasion I carried up and down stairs a large form of types in each hand, when others carried but one in both hands. They wondered to see, from this and several instances, that the Water-American, as they

called me, was stronger than themselves, who drank strong beer. My companion at the press drank every day a pint before breakfast, a pint at breakfast with his bread and cheese, a pint between breakfast and dinner, a pint at dinner, a pint in the afternoon about six o'clock, and another when he had done his day's work. I thought it a detestable custom, but it was necessary, he supposed, to drink strong beer that he might be strong to labor."

The idea that the temperate use of alcoholic liquor prolongs life is another mistaken notion, as is proved by the experience of life insurance companies. The following is from a letter received from Dr. Henry Tuck, Vice-President of the New York Life Insurance Company.

NEW YORK, February 24, 1900.

*Dear Sir:* Your letter of February 22d, asking my opinion, based upon my experience in life insurance, as to the effect of alcohol upon the human system, is duly received.

My personal opinion is that every well man, woman, or child is better without alcohol in any form.

To answer the one question that you ask, as to the effect of alcohol upon the length of life, it is proved beyond question that the habitual, though temperate use of alcohol is unfavorable to long life. This question has been carefully gone into several times within the past few years by some of the insur-

ance and medical journals, to which, if you care to go fully into the question, I would refer you for further information,

Yours very truly,

HENRY TUCK,

*Vice-President.*

There are in England and Scotland life insurance companies which separate their business into two sections. In one section they insure the lives of abstainers, those who do not drink alcoholic liquors at all. In the other section they insure the lives of people who are moderate drinkers. The records of these companies show that the use of alcohol, even in moderate amounts, shortens life.

**The appetite for alcohol.**—It is because the appetite for alcohol grows on one that many who begin as moderate drinkers, and intend to remain so, become hopeless drunkards. This is the greatest danger of moderate drinking. With many people, the small quantity of alcohol taken at first causes a desire for more and, as the appetite increases, larger quantities are taken, until the craving for alcohol becomes so strong that it cannot be resisted.

Any alcoholic drink may cause this unnatural and uncontrollable appetite for alcohol.

All people agree that the use of alcoholic liquor in large amounts results in great injury and misery. In every neighborhood there are men who were once kind-hearted, noble, and prosperous, but who have become wrecks through drink, and are so completely controlled by their appetite for it that they will secure it even at the cost of necessary food and clothing for themselves and families. Many, and perhaps all of these people, believed when they began drinking that they could control themselves and stop whenever they wished; but no one can tell in advance that the appetite for alcohol will not, in time, gain complete control over him. Since this is true, it is safe to say that the right course is not to begin to drink alcoholic liquors.

**We have learned that:**

1. Alcohol is made from sugar by fermentation.
2. Alcohol is not a food.
3. When alcohol produces intoxication, it acts as a narcotic poison.
4. The reports of life insurance companies show that people who do not drink alcoholic liquor live longer, on the average, than people who do drink it.
5. Some people drink alcoholic liquor because they have false opinions about it.
6. A great danger in the moderate drinking of alcoholic liquor is the forming of a habit of drinking that cannot be given up.
7. No one can tell beforehand whether he will become a slave to liquor, and therefore it is better not to begin to drink it.

## CHAPTER IX

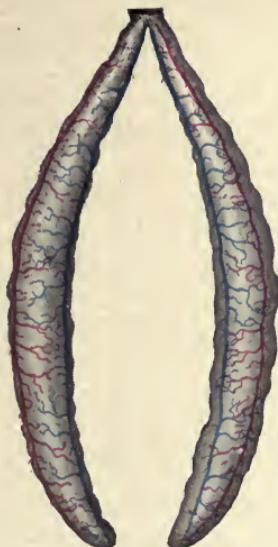
### BREATHING

**The need of oxygen.**—If you mix a handful of grain and a handful of chaff together and put them in a dish before a chicken, the chicken will pick out the grain, which it does need, and leave the chaff, which it does not need.

In somewhat the same way different organs of the body take what they need out of material which is brought to them, and do not take what they do not need. For example, air consists of gases mixed together. One of these gases is oxygen. As we breathe, air comes in through the nose or mouth and goes down the windpipe into the lungs. While the air is in the lungs they take from it oxygen, which we need, but, under ordinary conditions, leave the gases which we do not need.

If you had a glass jar full of oxygen you could not see the oxygen, yet it could be weighed, and if a rubber bag were filled with oxygen and you were to stand upon it, the oxygen would hold you up, just as water would if the bag were filled with water. We cannot live without oxygen any more than we can live without food.

**How we breathe.**—The act of breathing consists of two parts. We breathe in and we breathe out. When we breathe in we are said to inspire, or inhale; when we breathe out, we are said to expire, or exhale.



THE LUNGS OF A NEWT.

Breathing in is called inspiration, and breathing out is called expiration.

If you press your hands firmly against the sides of your chest, and breathe a few times, as deeply as you can, you will see and feel your hands moving as your chest becomes larger, and then smaller. The changes in the size of the chest are caused by muscles. One

of these muscles is the partition between the chest and the abdomen; the others are in the chest wall. When these muscles contract, the chest becomes larger; when they relax, it becomes smaller. When the chest becomes larger, it gives the lungs more room. The lungs swell out at once and air comes in to fill them. When the chest becomes smaller, it presses upon the soft, elastic lungs, and forces some of the air out.

**A simple lung.**—The lungs of animals are not all alike. A small animal, called the newt, has two very simple lungs. Each lung consists of a single air sac which swells out when air goes into it, and becomes much smaller when air goes out of it. However, the little sacs always contain some air. They are never quite empty.

On page 107 we have a picture of the windpipe and lungs of a newt when the lungs are full of air.

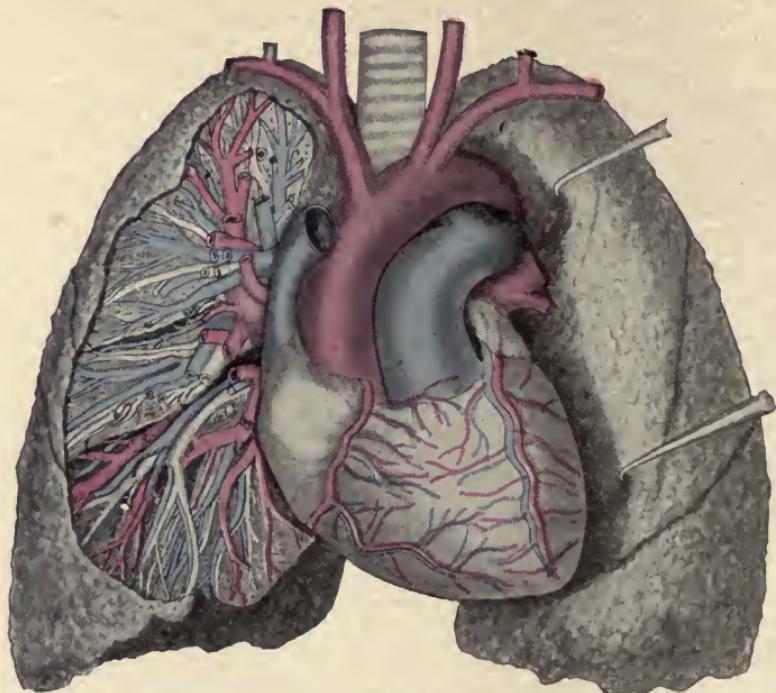
A great number of small, fine, hair-like blood tubes are fitted nicely into the walls of the air sacs. These blood tubes are the lung capillaries. You can see them sketched in the picture. There are two things for you to see in this picture,—the air sacs and the lung capillaries. The capillaries hold blood, the sacs hold air.

**What our lungs are like.**—We have two lungs; one on the right side and one on the left side of the chest. The windpipe divides at its lower end into two tubes, called the right and the left bronchus—one for each lung. Each bronchus sends out several branches, called bronchial tubes, which branch out like the limbs of a tree and end in little air sacs. There are thousands of small air sacs in each lung, and each of these air sacs has a network of tiny capillaries lying in its wall. As in a newt's lung, the capillaries hold blood, and the air sacs hold air.

**Changes in the blood in the lungs.**—The dark blood flowing along in the capillaries of the lungs has carbon dioxide in it that it must get rid of. The air in the sac has oxygen in it which it can give up. So, when the air and the blood come close to each other in the lungs, two things happen to the blood. Carbon dioxide goes out of it, and oxygen comes into it and turns it to a bright red color. Like ships at a dock, the little red corpuscles load up with oxygen in the lungs. Then they sail away in the blood stream to the left side of the heart.

**Changes in the air in the lungs.**—Changes also take place in the air in the lungs. Oxygen goes from it into the blood of the capillaries, while carbon

dioxide comes from the blood into the air. The air we breathe out has less oxygen and more carbon dioxide in it than the air we breathe in.



LUNGS AND HEART. PART OF LUNG CUT AWAY FROM LEFT SIDE TO SHOW BLOOD TUBES AND AIR TUBES.

**How good air is made bad.**—Now, the air which we breathe out has lost some of its life-giving oxygen, but contains more of the poisonous carbon dioxide, which has been brought to it from all parts of the

body by the blood in the veins. If we breathe in this same air again and again, it loses still more of its oxygen and takes up still more carbon dioxide. Each person breathes about eighteen times a minute, every breath taking oxygen from the air and adding carbon dioxide to it. So you see that the oxygen in a room full of people would soon be used up, and the air would contain a dangerous amount of carbon dioxide unless fresh air were let in.

A lamp or gas jet burning in a room takes away oxygen from the air and adds carbon dioxide to it, just as you do by breathing.

A damp, mouldy cellar may spoil the air in a house. The air cannot be wholesome when decaying fruit or vegetables are left in the cellar. Pipes connected with closets, sinks, baths, or wash-basins may allow gas to escape and make the air of a house poisonous.

Coal stoves give off much poisonous gas which should go up the chimney, but if the damper leading to the chimney is closed and the stove is left open, much of this gas finds its way through the house. Enough of it may escape in a few hours to cause the death of those who are in the house.

**The injurious effects of breathing bad air.—** You cannot have good health if you breathe bad air

day after day. Bad air affects the brain and causes headache and other uncomfortable feelings.

It affects the blood most of all. Those who spend much time in badly ventilated rooms are always pale. They have a sickly appearance because the little red corpuscles do not get enough oxygen. The muscles become weak owing to the poor quality of the blood.

Bad air, by weakening the body, makes you more likely to take any disease to which you may be exposed. The air from damp cellars and damp houses is a cause of bronchitis, rheumatism, and heart disease.

**Ventilation.**—The rooms of a house are usually well ventilated in summer because the doors and windows are kept open. The cellars, however, are often neglected, even in warm weather. Every cellar should have at least two windows, which should be placed so as to allow a current of air to blow through the cellar.

Houses are often badly ventilated in winter, for then the doors and windows are closed to keep out the cold air. It is true that even then some of the foul air of a house finds its way out, and some pure, fresh air finds its way in. This happens each time a door is opened. Unless the windows and doors are very tight, foul air will find its way out through cracks also, and fresh air will come in by the same way. In rooms in which a

fire is burning there will be another outward current of air through the chimney, while air will come in through the small openings around the windows and doors. Still, these means are not sufficient to furnish fresh air for the rooms of a house when the doors and windows are closed.

In every house there should be some special way provided so that a sufficient supply of fresh air may come into each room and the foul air may go out.

Thorough ventilation of the house is desirable, but that alone will not keep us in health. Every one should spend a part of each day out of doors. Fresh air and sunshine are better than medicine. On cold days put on extra clothing, but do not let cold weather keep you from going out. Those who go out every day are far less likely to take cold than those who are too much in the house.

**Effect of alcohol on the lungs.**—Alcohol weakens the tissues of the lungs and lessens their power to resist disease. Those who drink alcoholic liquor are more likely to have consumption of the lungs than those who do not drink it. It is well known, too, that those who are in the habit of drinking alcoholic liquor are less likely to recover from pneumonia than those who do not use it.

**Effect of tobacco on the throat and lungs.—** Smokers often suffer from a constant irritation of the throat and bronchial tubes, and even inflammation of the throat is common among them.

The practice of taking smoke into the lungs is always harmful. It irritates the lungs and allows a larger amount of poison from the smoke to be taken into the body.

**We have learned that :**

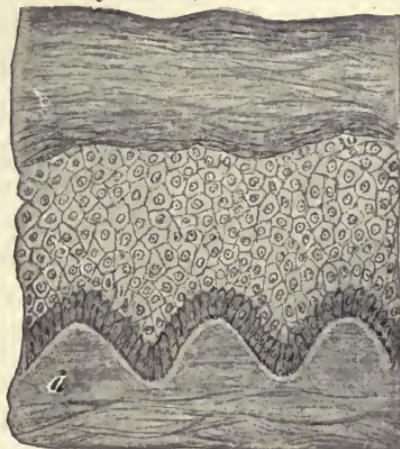
1. We breathe air in order to get oxygen from it.
2. In inspiration the chest increases in size, and in expiration it becomes smaller.
3. When the chest becomes larger the lungs swell out and air comes in to fill them.
4. When the chest becomes smaller it presses upon the lungs and forces air out of them.
5. The newt has very simple lungs.
6. Very fine blood tubes are in the walls of the newt's lungs.
7. Our lungs contain thousands of air sacs, each one of which is like a newt's air sac.
8. The air sac contains air, and the capillaries in its wall contain blood.
9. Oxygen passes from the air in the air sac to the blood in the capillaries, and carbon dioxide passes from the blood to the air.
10. Red corpuscles in the blood load up with oxygen in the lungs and carry it to all parts of the body.
11. Breathing bad air is injurious.
12. Houses should be well ventilated.
13. Alcohol injures the tissues of the lungs.
14. The throat and lungs may be injured by smoking tobacco.

## CHAPTER X

### THE SKIN

**What the skin is like.**—Our bodies have a soft covering of skin, which has two parts, an outer and an inner part. The outer part is called the scarf-skin and the inner part the true skin.

**The scarf-skin.**—The scarf-skin consists of cells arranged in several layers one upon another. Of course each layer must be very thin, because the whole scarf-skin is only about as thick as a thin sheet of paper. The outer layers are all the time wearing out and being rubbed off and, while this is going on, new cells are being formed in the lowest layer. These new cells keep pushing the cells above them out to the surface, to take the place of those that are worn away. Thus the scarf-skin is built up from below while it is wearing away above.



*a*, TRUE SKIN. *b*, LAYERS OF  
SCARF-SKIN.  
(Magnified.)

If you will rub your arm briskly while standing in the bright sunshine, you will see many dust-like specks floating in the air. These are worn-out cells from the outer layer of the scarf-skin.

The cells of the outer layers of the scarf-skin have no feeling, for they contain no nerves. If you prick the scarf-skin with the point of a needle you will feel no pain. Moreover, you will see no blood, unless the point of the needle passes on into the true skin, for the scarf-skin contains no blood tubes.

The coloring matter which gives us our complexions lies in the deepest layer of the scarf-skin.

If the scarf-skin is rubbed or pressed day after day it will become thicker. For this reason the skin on the palm of the hand and the sole of the foot often becomes quite thick and hard. This explains why boys who go barefoot in the summer can walk over rough, and even stony ground without hurting their feet.

**The true skin.**—The true skin lies under the scarf-skin. It is full of blood tubes and nerves. On page 118 there is a picture of a piece of true skin. Its surface is not smooth, but is raised at intervals into little points.

Most of these points contain a looped capillary;

some of them contain a nerve, while others contain both a capillary and a nerve. The nerves end in little knobs, and it is by means of these nerve ends that we feel everything that touches us.

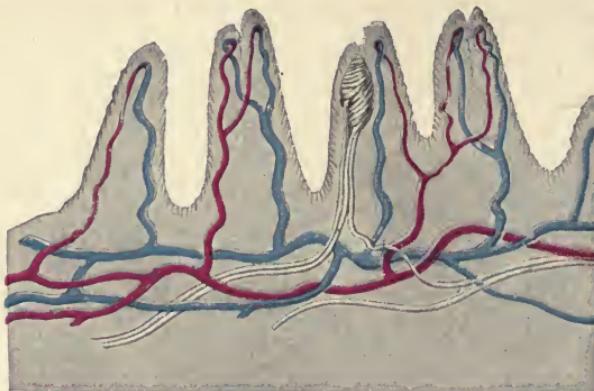
The true skin is so sensitive because of its many nerves that if the scarf-skin which protects it is removed, the uncovered place will smart with pain. Every boy knows this who has blistered his hands and then opened the blister, to let the water out. The raised skin that was above the water was scarf-skin; that below the water was true skin, full of nerves, and painful if touched, or even exposed to the air.

**Perspiration.**—If you run fast, or take other active exercise on a warm day, perspiration, or sweat as it is also called, will appear on the skin. Perspiration consists of water in which a very small amount of common salt and other matter is dissolved. It is formed in the true skin in what are called sweat-glands.

Perspiration will often collect in drops on the back of your hands, or run in little streams from your forehead. When it is formed slowly, it does not collect in drops, but as fast as it is made it passes from the body in vapor, which cannot be seen. Although you may not see it, perspiration is formed at all temperatures and at all times, whether you

are taking exercise, sitting still, or even lying in bed.

**Sweat-glands.**—On page 119 is a picture of a small piece of skin which contains sweat-glands. The lower part of the gland is twisted into a coil, and from the coil a small tube passes through both parts



NERVES AND BLOOD TUBES IN TRUE SKIN.

(Magnified.)

of the skin and opens on the surface of the scarf-skin. The cells in the coiled part of the sweat-gland take water and other materials from the capillaries surrounding them and make the perspiration, which then flows along the tube and out through the opening on to the surface of the skin.

If you will look at the skin on the back of your hand with a strong magnifying glass you will find it

dotted all over with tiny little holes. These holes are the openings of the perspiration tubes. They are called pores, and there are more than two million of them on the surface of the body.

**Use of perspiration.**—You have seen water sprinkled on a floor on a hot day and have felt the air in the room becoming cooler afterwards. The air became cooler because some of its heat was taken from it and used to change the sprinkled water into vapor, or evaporate it. The cooling of the body by perspiration is caused in the same way. Some of the body's heat is taken from it and used to change the perspiration into vapor.

When your body is becoming too warm the blood capillaries of the skin become larger, and a greater amount of blood than usual flows into them. The sweat-glands then work faster, so that a great deal of perspiration is made, and, as it evaporates, the body becomes cooler.



SECTION OF SKIN.

a, Sweat-glands. b, Hair shaft.  
c, Oil-gland. d, Muscle.

(Magnified.)

Cold acts in a directly opposite way. When the body is cold the blood tubes of the skin become smaller. They then allow less blood than usual to flow into them, and only a little perspiration is made.

Sometimes when people are very warm they allow themselves to cool off too quickly. They may go too soon into cold air, or may stand or sit after violent exercise without putting on extra clothing. This is a very common way of "catching cold."

**The nails.**—The nails on the upper sides of the ends of the fingers and toes do not look very much like scarf-skin, yet they are made of scarf-skin which has become very hard, almost like horn. The nails protect the ends of the fingers and toes.

When the nails are kept clean and neatly trimmed they are not only useful, but are also ornamental. Biting the nails injures them; they should be cut.

**The hair.**—Hair does not look at all like skin, yet it is made of changed cells of scarf-skin. The lower end, or root, of each hair is in the true skin, and the hair gets its nourishment from the blood in the capillaries of the true skin.

Near the root of each hair are glands which look like little bags. These are oil-glands. They take material from the blood in the blood tubes near

them, change it into an oily substance and pour it out upon the hair and skin to keep them soft.

The hair helps to protect the head from blows or other injury. It also keeps the head warm and serves as an ornament. The hairs which grow upon the edge of each eyelid are called eyelashes. The eyelashes catch particles of floating dust, and also act as a screen from the bright sunlight. Thus in two ways they protect the eyes.

The hair and the scalp should be washed thoroughly at least every two or three weeks. Begin by washing with soap and water that is quite warm, and afterwards use cold water. If you then dry your hair thoroughly, there will be no danger of taking cold even in winter weather.

**Care of the skin.**—You have already learned that the water of perspiration passes off as vapor, but the oil and other matter cannot evaporate. Together with the worn-out cells of the scarf-skin, they form a thin layer upon the surface of the skin. Part of the perspiration is absorbed by our clothing, and for this reason all clothing worn near the skin should be frequently changed and washed.

If the waste matters carried out of the body by perspiration remain upon the skin and clothing, they may

cause disagreeable odors, and interfere with the health of the skin. The skin and clothing should, therefore, be kept clean, for the sake of our own health, and also for the comfort of others.

**The bath.**—Persons in ordinary health should take a bath at some time every day. The best time is in the morning just after rising. Those who are accustomed to take a daily morning bath find it so refreshing that they are uncomfortable without it.

Warm water is more cleansing than cold, and soap helps to remove the oily matter which collects upon the skin. In order, therefore, to keep the body clean, it is necessary to use warm water and soap in the bath at least once or twice a week.

A warm bath at bedtime is soothing, after a day of hard labor or excitement. It has a quieting effect upon the nerves and is a valuable aid in producing sleep. But a warm bath should not be taken in the morning in cold weather if you are going out of doors soon afterwards, for it expands the blood tubes of the skin ; as these blood tubes become larger more blood than usual flows into them, and with much blood cooling rapidly at the surface of your body, you are likely to "catch cold."

If a warm bath is taken in the morning, the body

should afterwards be sprayed or sponged with cold water, to lessen the risk of taking cold on going out.

Cold water is much more bracing than warm. A bath is said to be cold when the temperature of the water is about 60 degrees Fahrenheit. Few people should use water that is colder than this.

At first a cold bath causes a feeling of chilliness, because the cold contracts the blood tubes of the skin, and more blood than usual is forced from the surface to the interior of the body, so that the internal organs receive an unusual supply. But the heart then works harder and drives the blood back to the surface. In this way a feeling which is called a glow is produced, and the bath should then come to an end. If the body is now rubbed



A SURF BATH.

with a coarse towel until it is thoroughly dried, a marked feeling of comfort will follow.

People who are accustomed to take a cold bath every morning seldom catch cold.

**Swimming.**—Swimming is a pleasant way of taking a bath. No one should remain in the water more than fifteen or twenty minutes. Five minutes are enough for some persons. If the glow which follows the first feeling of chilliness is followed by another chilly feeling, the swimmer has been in the water too long.

**Effect of alcohol on the skin.**—Alcohol, as we have seen, acts upon the nerves which control the size of the arteries of the skin and causes these arteries to become larger than usual. When the effects of a drink of liquor have passed away, the arteries return to their former size; but the continued use of alcohol causes the arteries to become permanently enlarged. The reddish appearance of the faces of those who drink a good deal of alcohol is caused by the extra amount of blood which the enlarged arteries of the skin contain.

**Effect of alcohol on the heat of the body.**—When alcohol enlarges the arteries of the skin they contain more blood than usual. This makes the skin feel warmer for a time, because the greater supply of blood at the surface warms the nerve endings in the

skin. It is this feeling of warmth in the skin that deceives those who take alcoholic liquor and gives rise to the false notion that alcohol makes the body warmer on a cold day.

The fact is that alcohol makes the body colder on a cold day. An unusual amount of blood is brought to the surface of the body and is there exposed to the cold. On this account heat escapes from the body more rapidly than it would if no alcohol were taken. The feeling of warmth that comes at first is soon followed by a temperature which is lower than usual.

It is well known that Dr. Nansen, Lieutenant Peary, and many other arctic explorers did not drink alcoholic liquor when they were in polar regions. Yet, if alcoholic liquor could keep a man warm, they would certainly have used it in those regions where there is little to be seen but ice and snow.

Years ago, when the effect of the use of alcoholic liquors was not so well understood as it is now, they were thought to be good for almost every ill and every kind of weather. On a cold day alcoholic liquor was taken to keep one warm, and on a hot day it was taken to keep one cool.

The following letters show that one is better off without it both in cold and in hot climates.

The first of these is from Dr. Frederick A. Cook, who has had polar experiences both in the Arctic and the Antarctic Oceans. He was the surgeon on the steamer "Belgica," which entered the Antarctic in January, 1898, to make explorations, and was frozen up in its ice for thirteen months.

687 Bushwick Avenue,  
BROOKLYN, N. Y., Jan. 8, 1900.

My dear Sir,

I have delayed answering your letter for some time because I had intended taking up the subject with a view of writing an abstract as to the uses and abuses of alcoholic beverages in polar work; but I find it is impossible for me to give the matter, at present, even the few moments of time which it requires.

Without going into a detailed account of my experiences, the principal expeditions with which I have been connected have been two; one where there was no alcohol in use except upon rare occasions, and the other where alcohol in the form of light wines was in almost constant use. From what I have thus seen of the use of stimulants, I must hasten to say that alcohol in every form is decidedly injurious to men whose endurance and strength are taxed to the utmost.

Alcohol, then, should have no place in the equipment of an expedition to the polar regions except as a part of the medical supply, and even for this purpose it is seldom useful.

Yours very sincerely,

FREDERICK A. COOK, M.D.



CANADA LOGS.

OTTAWA, ONTARIO, CANADA,  
November 21, 1899.

Dear Sir :

Timber and logs upon the Ottawa River and its tributaries are cut mainly at points from 150 to 300 miles north of the city of Ottawa. The winters are cold, and at times severe, the thermometer occasionally, though not often, reaching a point about 40° F. below zero. The cutting of roads, and the chopping, hewing and handling of logs and timber are heavy work, and though the hours of daily service for the men may be long, we find that wholesome food to eat and the universal *tea* to drink are far better fortifiers against severe cold and other hardships than any intoxicants could possibly be. The men, when the season's work is over in the spring, are, as a

rule, in a much healthier and stronger condition than when they began their duties in the autumn. A proper discipline therefore demands that in our own interest, as well as for the welfare of our men, we prohibit the use of alcoholic liquors wherever it is possible for us to do so.

Very truly yours,

F. P. BRONSON, Vice-President,

The Bronson Company.

The third letter is from General Francis V. Greene, who commanded the second Manila expedition.

11 Broadway,  
NEW YORK, November 22, 1899.

Dear Sir :

Your letter of November 17th is received, and in reply I beg to say that the second Manila expedition, consisting of about 3,500 troops under my command, sailed from San Francisco June 15th and arrived at Manila July 17th, 1898. The four ships used as transports were all passenger vessels, and contained the usual assortment of liquors for the use of passengers. The day before we sailed I directed that all alcoholic liquors be taken out of the ships and placed on the dock, and this was done. My reason for this action was that I believed that the men would arrive in a tropical climate in a better condition after such a long voyage through the tropics if their systems were entirely free from alcohol, and I think the result justified this belief. We landed immediately after arriving in Manila Bay, and for the next three weeks were subjected to extraordinary hardships in the trenches in front of

Manila. But the sick list was surprisingly small, being less than three per cent., and considerably less than it had been in the camp at San Francisco, before we sailed.

It is proper to state that there is a divided opinion as to the effect of alcohol on the system in the tropics, but my experience in this case, and what I had previously seen in the West Indies, confirms me in the belief that the use of alcohol is particularly injurious in the tropical climates, and the absence of it goes a long way towards enabling the northern races to withstand the effects of such climates.

Yours truly,

F. V. GREENE.

**We have learned that :**

1. The skin is a covering which protects the body.
2. The outer or scarf-skin has no blood tubes.
3. The scarf-skin consists of layers of cells. The outer cells are continually being rubbed off, while new ones are being formed in the lowest layer.
4. The true skin contains both nerves and blood tubes.
5. The surface of the true skin has many raised points.
6. Most of these points contain a capillary, some contain a nerve, and others a capillary and a nerve.
7. The skin contains sweat-glands which make perspiration.
8. One use of perspiration is to cool the body.
9. The nails and hair are made of changed cells of scarf-skin.
10. The skin should be kept clean.
11. We should not take a warm bath just before going out into the cold.
12. A cold bath, followed by vigorous rubbing with a coarse towel, improves the health.
13. Alcohol enlarges the small arteries of the skin and makes it red. When these arteries contain more blood than usual, the body loses too much heat.

## CHAPTER XI

### THE BRAIN, SPINAL CORD, AND NERVES

**The brain as the organ of the mind.**—How easily the engine runs along the railroad track and draws a long train. But the engine with all its strength is useless without an engineer to control it. With his hand on the lever he can stop or start the engine and make it go fast or slow as he wishes.

The mind is like the engineer, for it has control of the body. When your mind decides to turn a leaf of your book an order is sent out from your brain along certain nerves to the muscles of your arm and hand. When the order reaches the proper muscles they contract, and your arm and hand turn the leaf. In the same manner an order is sent out from your brain when you decide to walk, run, or move in any other way.

In addition to the orders which go from the brain to muscles, there are messages which come to the brain from the ends of the nerves in the skin and other organs of the body. For example, pressure on the skin of your finger starts a message which travels along a nerve till it reaches the brain. It is only

when this message reaches the brain that your mind knows your finger is touching something.

Besides giving orders and receiving messages, your mind can do other and higher things. It can remem-



THE BRAIN AS SEEN FROM ABOVE.

ber, it can imagine, it can reason, it can love, it can feel happy or sad. All its powers, however, act only through the brain, and for this reason the brain is called the organ of the mind.

**The appearance of the brain.**—The brain is a soft mass, like thick jelly. Its surface is folded so as

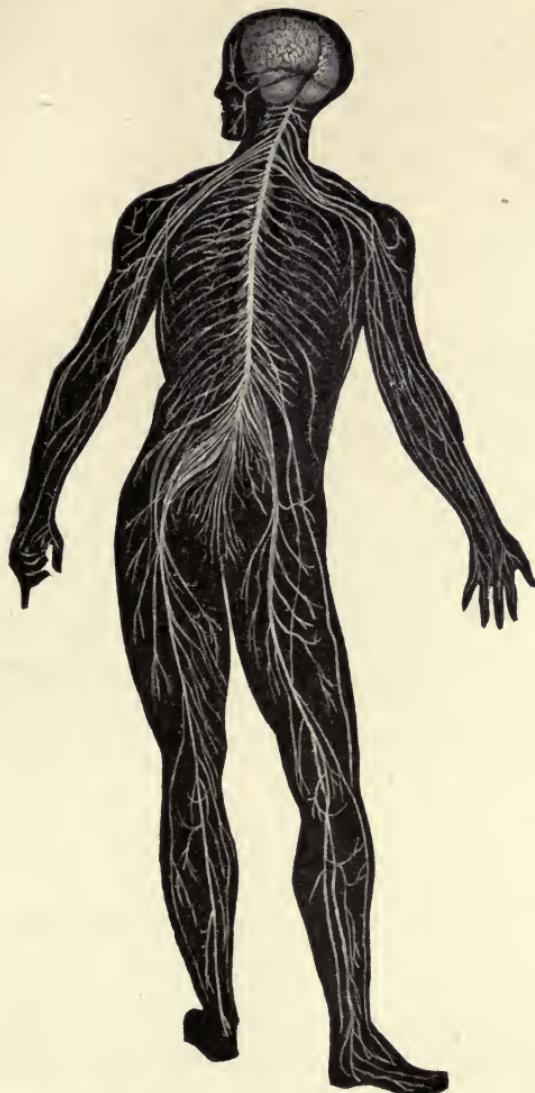
to form ridges with grooves between them. A very deep groove runs from the front to the back part of the brain and nearly divides it into two equal parts. Besides the large upper portion of the brain shown in the picture on page 131, there is a small lower portion, which you can see on page 133.

The brain is well supplied with blood tubes. Arteries pass through the neck and bring blood to the brain from the heart. These arteries divide into a great number of smaller ones which distribute the blood to all parts of the brain.

As the brain is soft it could be easily injured, so it is placed, for protection, inside a case of bone called the skull.

**The spinal cord and nerves.**—The spinal cord, which lies within the spinal column, is really a continuation of the brain. It is a soft, white cord about eighteen inches long. Throughout its entire length, glistening silvery threads, called spinal nerves, start from it in pairs.

There are thirty-one pair of nerves that begin in the spinal cord. Each spinal nerve is made up of fine nerve fibres. These nerve fibres are bound together to form a nerve, just as telegraph wires are bound together to form a large cable.



THE BRAIN, SPINAL CORD, AND NERVES.

The spinal nerves pass out into the body through small holes in the spine. Their fibres afterward separate and end in various parts. Some end in the skin, others end in muscles, and others in different internal organs.

Besides those that begin in the spinal cord, there are twelve pair of nerves that start directly from the brain and pass out through little holes in the skull. They go to the eyes, ears, mouth, nose, and to the skin and muscles of the head and face. A very important pair goes to the heart, lungs, stomach, and liver.

**How the nerves do their work.**—Nerve fibres extend downwards from the brain into the spinal cord. Spinal nerves connecting with these extend outwards from the cord to the muscles of the arms, legs, and other parts of the body. These nerves carry messages from the brain to the muscles, directing them to contract. The nerves can carry messages, but cannot start them. If all the nerves of your arm were cut you could not move the arm, for no messages could go from the brain to the muscles and cause them to contract.

Other nerves extending from the brain to the skin carry messages from the skin to the brain whenever anything touches the skin. If all the nerves extend-

ing from your brain to one of your hands were cut, you could not feel anything with that hand, for no message could go from it to the brain.

Messages carried by nerves travel very fast. It takes only a very small part of a second for a message to go from your brain to your hand, or from your hand to your brain.



ENTERTAINING WORK.

**Health of the brain and nerves.**—The nervous system and the rest of the body are closely united. The health of the one depends very much upon the health of the other. When you are in good health your nerves will be stronger and your brain will be clearer than when you are not in good health. Regular meals, regular hours for work, or exercise, and for

rest are needed as much for the brain and nerves as for other parts of the body.

**What work does for the brain.**—If you should keep your arm tied up in a sling for a long time it would become weak and would grow very slowly. Muscular work makes the muscles grow and become stronger, and brain work makes the brain grow and become stronger. When you study well you are not only getting knowledge, but you are at the same time gaining greater power of mind. For this reason good work at school will make you able to use your brain well after you leave school.

Nothing can be better for children than to have some entertaining work in addition to their games for leisure hours. Anything that one takes an interest in will furnish pleasure and be the means of gaining greater power of mind.

**Sleep.**—Sound sleep is necessary for the brain. During sleep the brain and nerves rest, and there is time then to repair what was worn out during the day, and also to lay up a store of energy for the next day. You should take care to get plenty of sleep if you wish to grow and be strong. A child requires more sleep than grown people because of his rapid growth. It is a good plan to have a regular time for

going to bed, and you will sleep more soundly if you spend part of each day in the open air.

**Effect of alcohol on the brain and nerves.**—The first effect of alcohol on the brain is to increase the amount of blood flowing through it. This unusual amount of blood in the brain produces a state of excitement, and while it lasts the mind works rapidly and easily. For this reason many are deceived and led to believe that alcohol makes them able to think better and more quickly.

But this early state of excitement rapidly passes away, for some of the alcohol that is in the blood soon reaches the brain and numbs the delicate brain cells. As a result, the brain then has less power to work than usual. Careful experiments have been made which prove this.

The condition of intoxication shows very plainly that alcohol injures the brain and nerves. When a man is intoxicated it is impossible for him to do any mental work well, and his nerves lose control over the muscles, so that he can hardly talk, and can only stagger when he tries to walk.

A large amount of alcohol will paralyze the brain and nerves and produce sleep. In this condition the brain loses all power to send out messages to the vol-

untary muscles, and also much of its power to receive messages from different parts of the body.

The long-continued use of alcohol causes in many persons a terrible disease of the brain cells and nerves, which is called delirium tremens.

**Tobacco.**—When the leaves of the tobacco plant are dried they are used for smoking, for chewing, or for making snuff.

Tobacco leaves contain a colorless, oily liquid which is called nicotine. It has a hot, burning taste, and a disagreeable smell. It is a powerful poison and is specially harmful to the nerves. Some nicotine is taken into the system whenever tobacco is smoked, chewed, or used as snuff.

The uncomfortable effects that are experienced when one is learning to smoke or chew are due to poisoning by nicotine. Faintness, dizziness, nausea, extreme weakness, and vomiting are some of the most usual of these effects. The skin also becomes pale, moist, and cold, and the pulse exceedingly feeble.

After a time the tissues of the body may become so accustomed to this poison that a person will feel scarcely any inconvenience from it, although the tissues themselves may be seriously injured by it.

All agree that the use of tobacco is injurious to

those who are still growing. In early life the tissues of the body, and especially those of the nervous system, are tender and have less power to resist the harmful influence of nicotine.

Cigarette smoking is the most harmful of all ways in which tobacco is used, because it teaches the use of tobacco to the young. Since each cigarette is small it contains only a small amount of nicotine. For this reason the beginner suffers less after smoking a cigarette than after smoking a pipe or cigar. Yet, one of the chief dangers of the cigarette lies in the very fact that it is small, for this is what makes it easy for young persons to begin the habit of smoking. In a short time one cigarette does not satisfy the smoker, and he soon learns to smoke a large number, so that a dangerous amount of nicotine is taken into the body each day. Again, the amount of nicotine that is taken into the body depends upon the amount of surface that the smoke comes in contact with. Cigarette smokers, as a rule, inhale the smoke, so that it comes in contact with the mouth, throat, and the larger bronchial tubes. On account of the increased surface thus exposed to the smoke, one who smokes cigarettes and inhales absorbs a greater amount of nicotine than one who smokes a pipe or cigar.

**Narcotics.**—Drugs which are used to relieve pain or to produce sleep are sometimes taken by persons who do not understand the dangers which attend their use. Such drugs, as opium, laudanum, morphine, chloral and cocaine, are called narcotic poisons because they deaden the nerves. They should be used only when they are prescribed by a physician, for an over-dose of any of them will destroy life. Besides this, they can create a strong desire for more, just as alcohol can, and when the habit of using them is formed it is very difficult to give them up.

**We have learned that :**

1. The brain is the organ of the mind.
2. The brain is soft and is protected by the skull.
3. The surface of the brain is folded so as to form ridges and grooves.
4. The spinal cord is a continuation of the brain.
5. Nerves extend from the spinal cord and the brain to all parts of the body.
6. Some nerves carry messages from the brain to muscles and cause them to contract.
7. Other nerves carry messages from the organs of the body to the brain.
8. Sleep is necessary for the brain and nerves.
9. Exercising the brain strengthens its powers.
10. Alcohol injures the cells of the brain and nerves.
11. Nicotine is a powerful poison which injures the nerves.
12. The use of tobacco hinders growth.
13. Narcotic drugs should be used only when ordered by a physician.

## CHAPTER XII

### THE FIVE SPECIAL SENSES

**How the brain gets information.**—Imagine a boy confined in a room so that he has no way of knowing what takes place outside, except by means of a telephone. Though he is completely shut in, he can yet receive messages and get information from the outside world.

Your brain, which is the organ of the mind, is shut in like the boy ; but nerves, like telephone wires, extend from the brain to all parts of the body. The ends of some of these nerves lie just under the scarf-skin, the ends of some are in the tongue, some are in the nose, some in the eyes, some in the ears. When anything from the outside world acts upon these nerves they carry messages to the brain ; so you see that although the brain is shut within the skull, yet, through its nerve telephones, it receives messages from the world outside the body. There are five different sets of nerve telephones over which messages thus come to the brain. We call them the five special senses,—touch, taste, smell, sight and hearing.

Sometimes a telephone wire breaks, or is otherwise

injured, and then no messages can come over it. It sometimes happens also that a nerve leading from some organ of the body to the brain is injured so that it will not carry any message to the brain. It may be that the nerves which carry messages from the eyes to the brain become unable to do their work. Then we are blind and through our eyes we can get no idea of the color and appearance of the birds, or flowers, or countless things that others see.

**The sense of touch.**—It is easy, with your eyes closed, to tell the difference between an apple and a peach if you touch them. They do not feel alike. When you feel anything you can tell whether it is hot or cold, smooth or rough. You can learn also something about its size and shape.

Nerves extend from the brain to the skin. When anything touches the skin, these nerves carry messages at once to the brain and we then get information about what we are touching. It is by means of the brain and the nerves of touch that we feel. In the skin of some parts of the body there are more nerves than in the skin of other parts. There are many nerves in the skin on the tips of the fingers, while there are not so many in the skin on the back of the hand. We can feel best with those parts that have most nerves.



THOMAS STRINGER AND HIS TEACHER, MISS CONLEY.

The sense of touch can be educated so as to become very keen. In many occupations it is a great help. Watch your mother, or the tailor, examine cloth by feeling it. The grocer tests flour or meal by rubbing it gently between his thumb and fingers, and the car-

penter feels the edge of his chisel or plane to find out if it is sharp.

Did you ever see blind persons read with their fingers? Their books are not like yours. Their letters are not made with ink, but are made by raising the paper into little points. By passing their fingers over these raised letters the blind are able to read almost as rapidly as you can. The blind use their fingers so much that they are able, by feeling, to learn a great deal that we learn by sight.

For those who are without both sight and hearing, the sense of touch is by far the most important way in which messages from the outside world come to the mind. In these days it is wonderful how much may be accomplished by one who can neither see nor hear.

The case of Thomas Stringer is a remarkable illustration of this. Thomas became blind and deaf as a result of illness, when he was three years of age.

In April, 1890, when he was four years and nine months old, he was admitted to the Kindergarten for the Blind in Boston. With much patience he was taught at last to know letters and words as his teacher spelled them in his hand with her fingers, and also to talk by making letters and words with his own fingers. Later he learned to write, and to read the

raised print in which books for the blind are printed. His studies in the primary department connected with the kindergarten included language, arithmetic, history, geography, physiology, science, and manual training. When he was thirteen years of age he entered the sixth grade of the Lowell Public Grammar School of Boston. His teacher who was with him in the kindergarten went with him to the grammar school to aid him in his studies. The principal of the Lowell School, Mr. E. P. Sherburne, writes of Thomas: He had no trouble in maintaining an average standing in the class, or grade, to which he belonged. He entered the ninth grade in September (1902), and graduated in the following June with his classmates who could see and hear.

**The sense of taste.**—The nerves by which we taste end in a soft membrane which covers the tongue and some other parts at the back of the mouth. This membrane is very much like the skin, and has in it little raised places, in which these nerves end. If you put a lump of sugar into your mouth the nerves of taste carry messages to the brain, which tell you that the sugar is sweet. It is by means of the brain and these nerves that we taste.

The sense of taste can be educated. Many people

who dislike bananas and tomatoes when they first taste them learn afterwards to like them very much. Children may dislike the taste of some article of food that is useful. By eating a little of it at a time one may learn to like it; and it is well to learn to like different things, for variety of food is necessary to keep the body strong and healthy.

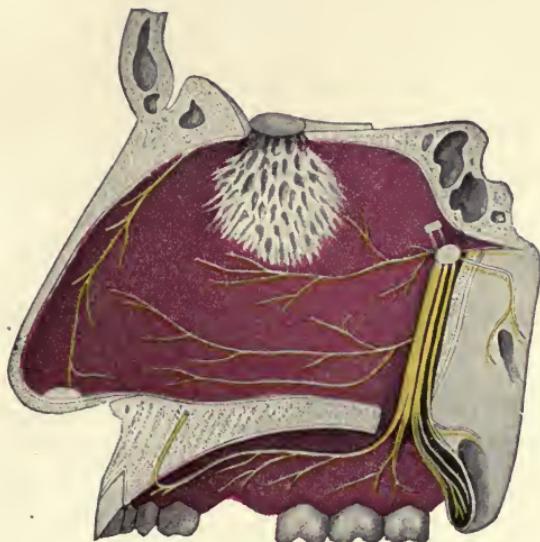
The sense of taste gives us pleasure. Children usually like sweet things, and every one enjoys the flavor of delicious fruits and well-cooked meals. Invalids, and others whose appetite for food is poor, are often induced to eat freely when food that is appetizing is offered to them, but will turn in disgust from food that does not please their taste.

**The sense of smell.**—The sense of smell is of value to us chiefly in two ways. It is a source of pleasure. The scent of many flowers is delightful, and the smell of many foods increases the pleasure of eating. The sense of smell also warns us against danger. Foul air and decayed matter often tell us of their presence by their odor.

The fine fibres of the nerves of smell are spread out in the lining of the upper part of the nose. When air containing an odor touches the ends of these fibres they carry messages through the nerves of smell to the

brain, and we know then what kind of odor we are smelling. It is by means of the brain and these nerves that we smell.

When only a small amount of odor is in the air we get a faint smell. If we wish to smell a faint odor



THE NERVES OF SMELL.

distinctly we sniff, and so cause the air to pass higher into the nose and make a stronger impression on the nerves of smell.

When we smell a strong odor, such as that of harts-horn, the power to smell faint odors is greatly lessened for a time.

Every one should be careful not to give discomfort to others by such unpleasant odors as are caused by eating onions, using tobacco or liquor, and by not keeping the body and clothing clean.

**The sense of hearing.**—The organ of hearing is the ear. The part of it which you can see is called the external ear, and is made of cartilage covered with skin. The external ear is of some use in collecting sound. You often see a person who does not hear well put a hand behind his ear to aid in collecting sound. Some animals, such as horses and rabbits, move their external ears in order to catch sounds better and to learn the direction from which they come.

The sounds pass from the external ear through a little tube, about an inch long, into the head. At the inner end of this tube there is a thin curtain which separates the external ear from the middle ear. This curtain is sometimes called the drum, but it should be called the drum membrane.

The middle ear is the drum. It is a small cavity in one of the skull bones. In it there are three small connecting bones. The first of these is fastened to the drum membrane at the outer end of the middle ear, and the third is fastened to a membrane at the

inner end of the middle ear. The middle ear requires air. This is supplied it through a little tube which connects with the back part of the mouth.

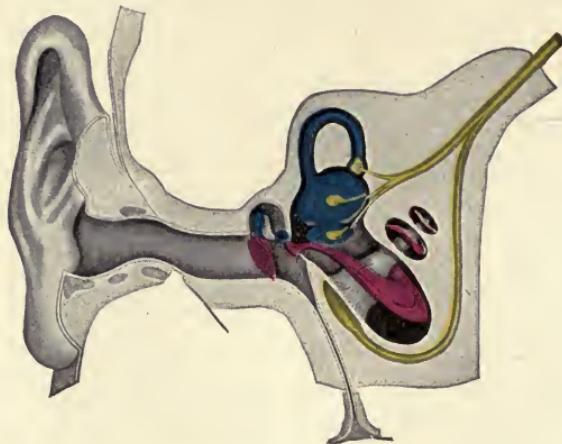
Just beyond the middle ear the skull bone is hollowed out into a little chamber, called the internal ear. It is irregular in shape, and is filled with a watery fluid. The ends of the nerves of hearing float in this fluid.

**How we hear.**—If you throw a stone into water little waves will form on the surface. If the surface is smooth you will see these waves moving outward in little circles. Whenever a bell or anything capable of making a sound is struck, similar waves are made in the air, these waves move outward in circles, and, if they strike against your ears, cause you to hear.

You cannot see these sound waves because you cannot see air. When they reach the ear they travel inward through the tube of the external ear, beat against the drum membrane and make it quiver, or vibrate. The vibration of the drum membrane sets the small bones of the middle ear in motion, and this causes the membrane at the inner end of the middle ear to vibrate. As this second membrane vibrates it sets the fluid of the internal ear in motion. The waves of the fluid then act upon the ends of the nerves of hearing and

cause messages to travel by these nerves to the brain. When any message reaches the brain over these nerves we say that we hear.

**Uses of the sense of hearing.**—The sense of hearing warns us of coming danger. The Indian puts his



SECTION OF EAR.

ear to the ground to hear if an enemy is approaching. The sound of a bell or the rumble of wheels tells us of the coming of a street car or wagon. Because they cannot hear such warning sounds, deaf people are in constant danger in the streets of a crowded city.

The sense of hearing gives us a great deal of pleasure. There are very few people who do not enjoy

some kind of music, or the pleasing voice of one who reads or speaks well.

It is easy to shut our eyes if we do not like what is before them, but it is not so easy to close our ears. Every one should, therefore, speak in a pleasing tone of voice, and should be careful not to make noises that are unnecessary and annoying. Many people are disturbed by the noises that others make thoughtlessly, both in the house and in the street.

**Care of the ears.**—The best way to take care of the ears is to leave them alone. They are delicate organs and can easily be injured. Never put anything into the ears. They should never be pulled violently, either in play or for punishment. A blow on the ear may break the thin drum membrane and cause dullness of hearing or even total deafness.

A “cold in the head” is a frequent cause of deafness. Whenever there is deafness from any cause a physician should be consulted without delay.

The sense of hearing can be wonderfully trained. The leader of a band can often tell what instrument among fifty is half a tone out of tune, or a quarter of a beat out of time. A railway company may have hundreds of engines, but the agent at a station often knows, by its whistle, which engine is coming.

In the schoolroom you should learn to do two things,—to attend to some of the sounds you hear, and to pay no attention to others. Practice will make you so perfect that you will hear only what you ought to hear. While other pupils are reciting only a few feet from you, you will be able to study your history or geography as well as if you were the only one in the room.

**The sense of sight.**—Sight is a precious gift. More pleasure and more information about things around us come to us through the sense of sight than through any of the other senses. How awkward and difficult it would be to travel or to do our work if we could not see!

**What the eye is like.**—The eye is nearly round like a ball, and for this reason is sometimes called an eyeball. It has an outer coat which consists of two parts. There is a clear, glassy, circular part in front, which is the window of the eye, and there is a white part which covers the rest of the eye. Some of this white part can be seen, but most of it cannot. Both parts of the outer coat are tough and strong so as to support the delicate parts inside.

Like all other parts of the body the eye needs blood to nourish it. Just inside the white part is a

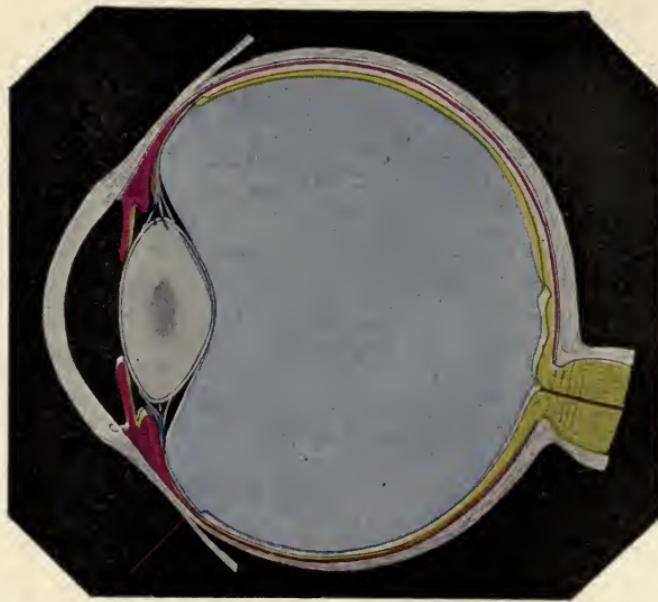
network of arteries, capillaries and veins. This network forms the second, or middle coat of the eye.

It would not be well for the eye if too much light were allowed to come into it at one time. When too much sunlight comes in through our windows we close the curtains. Just inside the window of the eye is a curtain. It is called the iris. The word iris in another language means rainbow. It is the colored part of the eye and consists of a circular curtain with a small hole, called the pupil, in the centre. When the light is too strong the pupil becomes smaller so as not to admit too much light. When, on the other hand, the light is dim, the pupil becomes larger in order to admit more light.

You may have seen boys use a lens to collect the rays of heat from the sun and set fire to paper or wood. Just behind the iris is a lens in the eye which looks like glass. It gathers together the rays of light which enter the eye, and causes them to make a clear image on the back of the eye.

The lens divides the inside of the eyeball into two parts. The part in front of the lens is smaller than the part behind the lens and is filled with a watery fluid. The part behind the lens is filled with a thicker, glassy fluid.

The nerves of sight enter the eyes at the back. The fine fibres of these nerves are spread out in a thin layer on the inner surface of the second coat of each eye, and thus form the third coat.

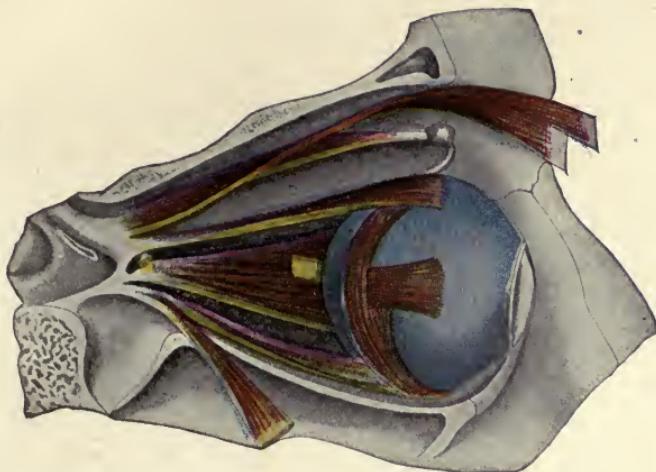


THE COATS OF THE EYE.

Whenever you look at an object and see it clearly, it is because light from the object has entered the eye and made a picture on this third coat. It is the picture that causes the nerves of sight to carry messages to the brain, which tell us what we are looking at.

It is by means of the brain and the nerves of sight that we see.

The eyelids are like folding doors. When they are closed they protect the eyeball from injury.



THE MUSCLES OF THE EYE.

The eyelashes, too, help to protect the eye from too much light, and also from dust and other small objects floating in the air, when the eyelids are open.

At the outer, upper corner of each eye is a small gland in which a watery fluid, called tears, is made. Generally this gland makes only a small amount of fluid, but when you cry the gland works rapidly and tears are made in greater quantity. The chief use of

tears is to keep the eyeball moist. Each time you wink, the eyelid moistens the eyeball with tears, just as you may moisten a piece of glass with a damp sponge. Tears also wash away particles of dust that light upon the eye.

We can move our eyeballs. Muscles, as you see in the picture on page 155, are fastened to the sides of the eyeballs. When one of these muscles contracts, it moves the eye. If from any cause the muscles on one side become weak, the eye may be turned too far toward the other side. This condition is called squint eye.

**Care of the eyes.**—The eyes may easily be injured by reading fine print in a poor light, or by reading in a light that is too bright.

The direction in which the light comes when you are reading is important. If possible do not read or write while facing the light, but sit so that the light may fall upon the page from your left.

Reading in bed is a bad practice. The eyes are likely to be strained because of the position of the book and the direction from which the light comes to the eye. You should stop reading the moment your eyes smart or burn or feel as if fine sand were in them. When reading you should stop at intervals and look

away at something in the distance for a few minutes. Looking constantly at near objects tires the eyes, while looking at distant objects rests them.

**Effect of alcohol and tobacco on the special senses.**—The harmful effect of alcohol and tobacco upon the brain and nerves must injure the special senses. Experiments have shown that even small amounts of alcohol may injure the sense of sight, and also the sense of touch.

The use of tobacco sometimes causes a well-known disease of the eye, in which the nerves of sight become seriously injured by inflammation. In this disease the power of vision may be lessened, and in severe cases it may be entirely lost.

**We have learned that :**

1. There are five ways in which messages may reach the brain.
2. One of these ways, the sense of touch, is through nerves which end in the skin.
3. We feel best with those parts of the skin which contain many nerves.
4. The sense of touch warns us of danger, and gives us also a great deal of information.
5. A second way, the sense of taste, is through nerves that end in the membrane that covers the tongue.
6. We should learn to like the taste of useful articles of food, if we do not like them.
7. A third way, the sense of smell, is through the nerves which end in the membrane that lines the nose.

8. A fourth way, the sense of hearing, is through nerves that end in the ears.
9. The drum membrane is stretched across the inner end of the external ear.
10. In the middle ear three small connected bones connect the drum membrane with a membrane at the inner end of the middle ear.
11. The internal ear lies behind the middle ear, and contains a watery fluid in which the ends of the nerves of hearing float.
12. Sound waves of air beat against the drum membrane. Each beat is repeated by means of these bones on the inner membrane, and, as a result, the watery fluid behind it acts upon the nerves of hearing and causes us to hear.
13. A fifth way, the sense of sight, is through nerves that end in the eyes.
14. The eye has a strong outer coat to protect it.
15. Inside the white part of the outer coat is a network of blood tubes, which forms the second coat of the eye.
16. Fibres of the nerves of sight are spread out in a thin layer on the inside of the second coat.
17. Rays of light from an object enter the eye and make an image of the object on this layer of nerve fibres, which cause us to see the object.
18. A little gland above each eye supplies it with a watery fluid called tears.
19. Muscles are fastened to the eyeball and allow us to move it in different directions.
20. We should be careful how light falls on the page we are reading.

## APPENDIX

### WHAT TO DO BEFORE THE DOCTOR COMES

Accidents happen constantly. Every day some one is cut, or burned, or swallows poison by mistake, or falls and is badly hurt. As it is not always possible to secure the services of a physician immediately in such emergencies, every one should learn how to give aid to the injured.

**Burns or scalds.**—The clothing should be removed with great care, so as not to cause an increase of pain, or to disturb the injured parts. The pain may be relieved by covering the burned part with cloth that has been wet with a warm solution of common baking soda. Apply glycerine, vaseline, lard or flour to cover the burned surface and protect it from the air. Do not put cold water on a burn. Everything applied to a burn or scald, or to any wounded surface, should be perfectly clean.

**Clothes on fire.**—Very serious injuries are caused by burning clothing. If anybody's clothing catches fire, wrap tightly about him a coverlet, coat, blanket,

shawl, rug, table cover, or something of the kind that can be had, so as to smother the flames. If nothing suitable for wrapping is at hand, have him sit or roll on the floor, so as to cover the burning garments with his body, and try to smother the flames in that way.

The person whose clothes are on fire should never run—running only makes the fire burn more quickly.

To avoid swallowing flame when the clothing is on fire, one should cover the mouth and nose with the arm and lie down on the floor.

**Fainting.**—A person who has fainted should be placed flat on the side or back, with the head as low as the rest of the body, or even a little lower. If the body is in this position, blood will flow to the head, and the faintness will pass off in a few minutes. Always allow plenty of fresh air.

Smelling-salts or camphor may be placed under the nose, but are not often required.

Do not dash cold water on a fainting person. Moisten the face with a wet cloth, or apply to the forehead a cloth wet with cold water. Do not force anything down the throat of a person who is unconscious, for he may in this way be choked to death.

**Fits or convulsions.**—Place the patient in a com-



THE POSITION FOR A PERSON WHO HAS FAINTED.

fortable position on the side or back, loosen the clothing so as to allow easy breathing, and then avoid moving or disturbing him. If the face is red, place the head on a pillow; if it is pale, let the head be low.

**Suffocation.**—Suffocation is frequently caused by coal gas from a furnace or stove, by gas used for lighting houses, by gas at the bottom of old wells or in coal mines, and by the fumes of burning charcoal.

In a case of suffocation from any cause, remove the patient at once to the open air, loosen all tight clothing that hinders breathing, and moisten the face and chest with cold water.

**Sunstroke.**—Remove the patient at once to a cool

place, and rub the body with ice, or apply plenty of cold water.

**Frostbite.**—Rub the frozen part with snow or cold water, then wrap it in a wet cloth. The frozen part should never be warmed quickly, but always slowly.

**Sting of bees, wasps and other insects.**—Re-

move the sting, if it is left in the wound, and apply ammonia water, a solution of baking soda, or a little wet clay.

**Snake bites.**

—If the bite is on the hand or leg, tie a handkerchief or stout cord loosely round the limb above



TO TREAT SNAKE BITE.

the wound and twist it tightly with a stick, to prevent the poison from being carried upwards to the rest of the body. Some one should suck the wound

as quickly as possible, spitting out what is thus taken from the wound. There is no danger in doing this if there are no sores in the mouth.

**Dog Bites.**—If the bite was made by a healthy dog, wash the wound with clean cold or hot water, and then apply a pad wet with water. If the dog is known to be mad, treat the bite in the same way as a snake bite.

**Cramps.**—Sudden, sharp pains in the abdomen are often caused by eating unripe fruit, vegetables, or other indigestible food. Give castor oil, and apply cloths soaked in hot water, or a bottle of hot water, to the abdomen. If these measures fail to give relief in a short time, send for a physician.

**Bleeding.**—The quickest and safest way to stop bleeding from a wound of any kind is to place a finger or thumb directly upon the spot that bleeds.

Moderate pressure on the bleeding spot will stop the bleeding at once, whether the blood comes from an artery, from a vein, or from capillaries.

Keep the finger applied to the wound for ten or fifteen minutes and then remove it slowly.

If the bleeding begins again, apply the finger once more, and continue the pressure until medical aid can be secured.

Another way to stop the bleeding of a limb is by the use of a tourniquet. To make a tourniquet, first tie a knot in the centre of a handkerchief or a piece of cloth. Place this knot just above the bleeding point, and tie the ends of the handkerchief about the wounded limb. Put a stick inside the knot that ties the ends and twist hard to get pressure on the blood tube that is bleeding.

**Nose-bleed.**—Press firmly on the side of the nose from which the blood comes, so as to close the bleeding nostril completely. At the same time incline the head slightly forward, to keep the blood from running down behind into the throat. If blood comes from both nostrils, close them both by pressing firmly on both sides.

If this plan fails, the nostril may be plugged with cotton, or with a plug made from a narrow strip torn from a clean handkerchief or other garment. The strip may be dipped into ice water or alum-water, if either is at hand.

Remove the plug gently after five or six hours.

If the bleeding begins again, put in another plug and send for a physician.

Be careful to avoid blowing the nose for some time after the bleeding stops.

**Foreign bodies in the nose.**—If a foreign body, such as a pea or a bean, gets into the nostril, blowing the nose may remove it, or it may be hooked out with a looped wire or a hairpin.

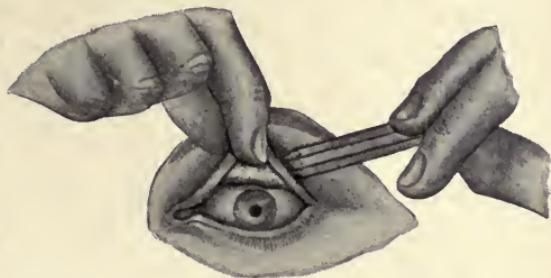
If the first efforts at removal are not successful, leave it alone and send at once for a physician.

**Foreign bodies in the ear.**—Foreign bodies sometimes get into the ear. Insects occasionally crawl into it and cause great pain. The delicate drum membrane may be injured unless great care is used in removing such bodies. It is therefore much safer to have them removed by a doctor.

**Foreign bodies in the eye.**—

A cinder or a bit of dust on the inner surface of the eyelid or on the surface of the eyeball may be wiped off easily with the corner of a clean handkerchief, or be washed out by bathing the eye. If these simple measures are not successful, obtain the aid of a physician without delay.

**Foreign bodies in the throat.**—Small pieces of food, bones or other foreign matter may become lodged



REMOVING A FOREIGN BODY FROM THE  
EYELID.

in the throat and cause choking. If they are not coughed out quickly, they can often be removed with the first finger.

A few smart slaps on the back between the shoulders, while the body is bent forward, will often give instant relief.

Such foreign bodies as coins, pins, bones, and a great variety of similar things, are sometimes swallowed accidentally.

In such cases it is not wise to give purgatives, nor is it wise to cause vomiting. Give quantities of mashed potatoes and pancakes, and withhold all other food for a day or two. The foreign bodies become coated over if such foods as these are given, and pass along the intestine in the natural way without doing harm.

**Broken bones.**—A broken bone should be kept as still as possible. If it is moved about, the broken ends, which are usually sharp and jagged, may injure the surrounding soft parts.

A patient with a broken bone should not be moved, if he can be made comfortable where he is until the doctor comes. The injured limb should be supported on a pillow, or anything soft, and kept in the position in which it is most comfortable.

Whenever it is necessary to move the patient before the doctor comes, it is best to use some form of temporary support to keep the broken bone steady and prevent further injury.

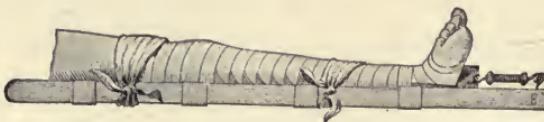
In the fractures of the arm or collar bone, a sling gives all the support that is required. If the bone that extends from the elbow to the shoulder be fractured, the sling should support the hand and wrist only. If the collar bone or the bones that extend from the elbow to the wrist be fractured, the sling should be wide enough to support the whole of the arm below the elbow.

Splints are required when the bones of the leg are broken. A thin strip of board, a walking-cane, an umbrella, or any straight stick may be used. Two splints should be employed. One should be placed on



A NEATLY BANDAGED  
ARM.

the outer side of the leg and the other on the inner side. The splints should be padded to prevent pain from pressure. They may be padded with cotton, pieces of cloth, moss, grass, or any soft material at hand; and they should be held in place by bandages, handkerchiefs, straps, cords, or by strips of cloth of any kind.



BROKEN LEG IN SPLINTS.

**Poisoning.**—A physician should be sent for without delay whenever poisoning is suspected, but do not wait for the physician to come before trying to relieve the patient.

*In most cases of poisoning, the first thing to do is to make the patient vomit, and thus expel the poison from the stomach.* The exceptions to this rule are where strong acids or alkalis have been swallowed.

In order to produce vomiting, give large quantities of warm soap suds, or a mixture of mustard and water, in the proportion of a tablespoonful of mustard to a pint of water, or salt and water, in the proportion of two tablespoonfuls of salt to a glass of water. If

none of these can be had quickly, give large draughts of warm water.

One or two cupfuls of any one of these simple emetics should be swallowed instantly. Then vomiting may be excited by putting a finger down the throat or by tickling the back part of the throat with a feather. As soon as the first attempt at vomiting is over, more water, soap suds, mustard and water, or salt and water, should be given, and vomiting should be excited again.

Repeat this several times in order to be sure that all the poison is washed out of the stomach.

Send, in the meantime, for the proper antidote for the poison that has been taken, and give it without delay. The following is a list of common poisons with their antidotes:

*Sulphuric acid or oil of vitriol.*—Give, in a teacup of water, two or three tablespoonfuls of any of the following: baking soda, magnesia, chalk, whiting, or plaster from a wall. Do not induce vomiting.

*Oxalic acid, or salts of lemon.*—Give, in a teacup of water, two or three tablespoonfuls of chalk, magnesia, whiting, lime, or plaster scraped from a wall. Do not induce vomiting.

*Carbolic acid.*—Give two or three glasses of milk,

followed by two or three tablespoonfuls of sweet oil or castor oil. Do not induce vomiting.

*Ammonia or hartshorn.*—Give four tablespoonfuls of vinegar in a teacup of water, or give lemon juice or orange juice, followed by two tablespoonfuls of sweet oil. Do not induce vomiting.

*Alcohol.*—Try to induce vomiting. Give strong coffee, and apply cold water to the head.

*Arsenic or Paris green.*—Try to induce vomiting. Give three or four tablespoonfuls of magnesia in a teacup of water, or give castor oil, sweet oil, lime water, raw eggs and milk. Get dialized iron from a drug store. Directions for its use accompany the preparation.

*Copper or blue vitriol.*—Try to induce vomiting. Give white of eggs and milk.

*Lead, sugar of lead.*—Try to induce vomiting. Give white of eggs and flax-seed tea.

*Mercury, bichloride of mercury or corrosive sublimate.*—Try to induce vomiting. Give milk, white of eggs, and flour in water.

*Opium, or the following drugs which are made from opium or contain opium: morphine, laudanum, paregoric, Dover's powder, Godfrey's cordial, soothing syrups.*—Make the patient vomit, and keep him awake

by tapping him on the forehead with the finger nails, or by striking his face with the end of a wet towel. Be very careful not to allow him to become cold. Keep him on his feet. Do not let him lie down or sit down.

*Phosphorus*, used in making matches and in rat poison.—Try to induce vomiting. Give two or three tablespoonfuls of magnesia or chalk in a teacup of water. Avoid giving oil or fat.

*Turpentine*.—Try to induce vomiting. Give two tablespoonfuls of Epsom salts in half a teacup of water, and large quantities of flaxseed tea.

*Toadstools and poisonous berries*.—Try to induce vomiting. Give two tablespoonfuls of Epsom salts in half a teacup of water, and castor oil.

**How to avoid poisoning accidents.**—These unfortunate accidents would scarcely ever occur if all bottles and packages containing poison were kept by themselves in a suitable place. A bottle of carbolic acid or liniment, for example, should never be placed on a shelf beside a bottle of medicine that is intended for internal use. It is dangerously easy, especially at night, to mistake one for the other.

*Keep all poisons locked up in a place set apart especially for them.*

A label, with the name of the contents plainly

marked on it, should be put on every bottle or package, whether it contains poison or not. If the label is lost, throw away the contents of the package or bottle.



ARTIFICIAL INSPIRATION.

One mistake may cost many times the value of what is thrown away.

**What to do in a case of drowning.**—In a case of drowning the first thing is to get the body out of the water. Unless the weather is severe, do not wait to

carry the patient to a place of shelter, but try at once to revive him. There are two things that you want to do—restore breathing, and get the body warm. Loosen the clothing about the neck and chest, and turn the body face down. Then wipe out the mouth and throat with your finger, covered with a clean cloth, or handkerchief.

While the body is face downward place your hands under the abdomen, and raise the body until the forehead just rests on the ground, so that the water in the mouth and throat may run out.

Then turn the body on its back, and place a roll of clothing, or something else a few inches high, under the shoulders so as to raise the chest. This straightens out the neck, and holds the chin away from the chest.

As the patient lies on his back insensible, the tongue is apt to fall back into the throat, and close the air-passage which leads from the mouth to the lungs. The tongue, therefore, should be carefully drawn well forward, out of the mouth, and held in that position, to allow the free passage of air to the lungs. It can be held more easily if a handkerchief or cloth is used, as in the picture.

Artificial breathing can then be produced by movements which cause the chest to become alternately

larger and smaller, as in natural breathing. One of the best ways of doing this is by Sylvester's method.

Have some one kneel behind the head of the patient, and grasp his arms just below the elbow, then swing



ARTIFICIAL EXPIRATION.

them around from the body until they are parallel with the head. This movement causes the chest to become larger. The lungs expand, and air goes in to fill them as in natural inspiration. After a slight

pause, bring the arms back to their first position beside the body, and press firmly against the lower ribs. This movement lessens the size of the chest and forces air out of the lungs, as in natural expiration. The movements should be repeated about sixteen times a minute, and should be kept up either until natural breathing is restored, or until a physician declares that the heart has ceased to beat.

Since recovery sometimes takes place after artificial breathing has been kept up for two or three hours, do not be easily discouraged. Natural breathing commences feebly, and it should be aided as much as possible by swinging the arms back at the time of natural inspiration, and bringing them down to the sides at the time of natural expiration, until the breathing becomes strong.

Natural breathing may be stimulated by holding smelling salts or hartshorn near the nose, but strong hartshorn should not be held too close, as it may cause injury to the inside of the nose.

Besides working to restore natural breathing, try in every possible way to get the body warm. Have the clothing removed as soon as possible, and the body dried gently. Cover it with any dry blankets, shawls, or clothing that can be obtained. Place along the

sides of the trunk and limbs any hot stones, bricks, boards or sand that have been heated by the sun, or any hot water bottles, or other objects that can be secured. Have the limbs and trunk rubbed gently but firmly towards the chest, so as to produce warmth, and also to aid the blood in its return to the heart. As soon as the patient can swallow, give him frequently hot drinks, such as tea, coffee, or even water. He may also be given, as a stimulant, half a teaspoonful of aromatic spirits of ammonia in a tablespoonful of water, every half hour, till the feet and hands become warm, and the patient feels comfortable. When he feels well enough to be removed, he should be carried carefully, with head low, and put into a warm bed. Some one should remain with him for a while so that prompt measures may be taken if breathing should again stop.

**Causes and prevention of disease.**—Disease may be caused by improper food, by over-eating, by impure drinking water, by the use of alcoholic liquors, or of tobacco, by unhealthful surroundings, bad habits, lack of exercise, and in other ways.

Some diseases, such as measles, scarlet fever and smallpox are contagious. The germs which cause these diseases are given off from the bodies of those

who are sick with them, are carried in some way through the air, and enter the bodies of those who are near. The germs of contagious diseases may be carried from a distance in letters or books, clothing, toys, furniture, and similar objects.

The germ that causes diphtheria is contained in the saliva, and in the discharges from the nose and mouth of a patient ill with this disease, but it is not carried by the breath.

Consumption of the lungs may be given to one person by another. The germ which causes consumption is always contained in what a patient, who is ill with consumption, coughs up. This is called the sputum. If it becomes dry, it will mingle with the dust in the air and may be inhaled by others. Both the patient and the family should do their best to prevent this by disposing of the sputum in the right way.

It may be received into a spittoon containing a little water, and afterwards be buried or emptied into



CONSUMPTION GERMS. (Magnified.)

the sewer. Or it may be received on a piece of cloth and then be burned. So long as the germs are kept moist, they are harmless.

Every one should be careful not to use a cup or other drinking vessel that has been used by one who has sore throat, sores on the tongue, in the mouth, on the face, on the lips, or on other parts of the body. All those who have sore eyes, or any kind of sores of the skin, should always use a separate towel.

Great care should be taken to prevent, as far as possible, the spread of contagious disease. In such diseases the patient and his nurse should be kept away from the rest of the family, until all danger of contagion is past. The clothing, rooms and furniture of the whole house should be thoroughly cleaned and made harmless according to the doctor's directions.

Cleanliness will do a great deal towards preventing disease. The germs that cause disease often cling to dust. For this reason walls, floors, curtains and clothing should be kept as free from dust as possible.

Flies and mosquitoes often carry disease germs and leave them on our food, or force them into our bodies. Except at meal time, all food should be kept covered, so that flies cannot get at it, and doors and windows should be screened so as to keep flies and

mosquitoes out of the house. It has been shown by experiment that malarial and yellow fevers are probably due to mosquito bites.

Fresh air and sunlight are great purifiers. Both should be admitted freely to our homes. Clothing, bedding and furniture should from time to time be put out in the sunlight, so that any germs they may contain may be destroyed.

Clothing that is worn during the day should not be worn at night, but should be hung up, to air and dry.

## EXPERIMENTS

(For the Teacher)

A NUMBER of good specimens for object lessons in physiology may be obtained without difficulty. These should be carefully prepared before they are brought into the class room. All blood stains and superfluous tissue, such as fat and skin, should be removed from fresh specimens so as to have them as neat as possible. After they are made ready, they should be kept in damp cotton cloth till they are used.

In addition to specimens, a sharp knife, a pair of scissors, a few large plates, and a few towels will be needed.

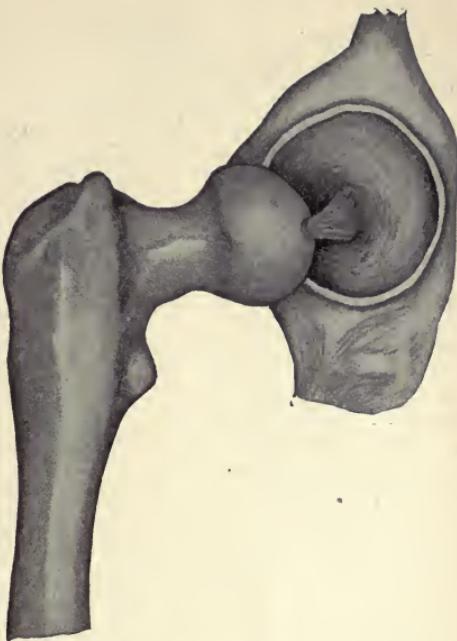
### BONES

**To show structure of bone.**—Ask a butcher to prepare the shin bone of a sheep, or calf, by sawing it across the middle, and by sawing one of the pieces into halves lengthwise.

(1) Show the central cavity of the shaft, and the ring of solid bone surrounding it.

(2) Compare the shaft with the end of the bone, and observe that there is no cavity in the end.

(3) Compare an old dry bone with a fresh one, and notice their different appearance. Small holes may be seen in dried bones, showing where arteries entered to carry blood for the nourishment of the bones.



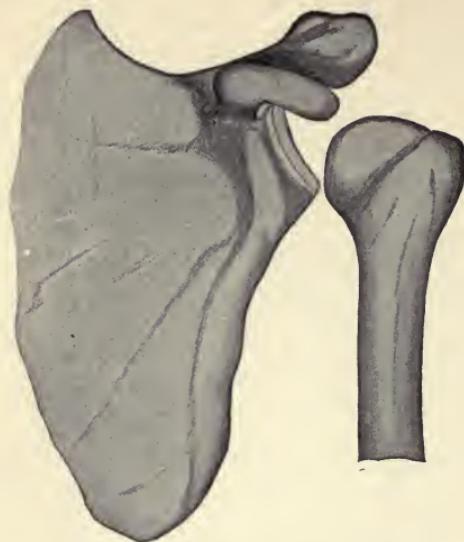
BALL AND SOCKET OF HIP-JOINT.

**Joints.**—Get a fresh knee-joint from the fore leg of a sheep. Have the bone cut off about three inches above the joint, and three inches below it.

(1) Show the movement which this joint allows.

(2) Cut the joint open and show the joint oil, or synovial fluid.

(3) Show the firm, tough ligaments that form the side walls of the joint.



BALL AND SOCKET OF SHOULDER-JOINT.

Partially dissect out a ligament, leaving one end fastened to the bone, and show its action.

(4) Show the smooth surface of the cartilage which covers the ends of the bone.

Try to get also the ball and socket of the hip-joint of a sheep. If this is impracticable, get the joint from

a fresh ham, or the hip-joint of a chicken or turkey.

(5) Show the ball of this kind of joint and the socket into which it fits. Have the pupil notice how freely the ball can move in different directions in its socket.

(6) Compare the freedom of movement of the ball and socket joints with the more limited movement of the knee-joint.

(7) Compare also the free movement of the shoulder-joints with the more limited movement of the elbow-joints.

## MUSCLE

Fresh, lean meat of any kind will serve well to illustrate the appearance of muscle.

(1) Get a small piece of lean corned beef, with the fibres running in the same direction. After it has been boiled, you will be able to separate the fibres of which the muscle is composed, because boiling softens the connective tissue that holds them together. Use a magnifying glass to show the finest fibres.

(2) Have each pupil grasp his arm between the shoulder and the elbow, then bend the arm up and down at the elbow. The biceps muscle will be felt swelling up in the middle, as it contracts, and becoming smaller, as it relaxes. Have a pupil with a large biceps bare his arm and show the contraction and relaxation of the muscle.

(3) Have the pupil notice the tendons of the back of his hand, as he opens and closes it.

(4) The position and shape of some of the muscles in the lower part of the leg of a chicken or turkey may be easily shown. Cut off the lower part of the leg before it is cooked. Remove the skin and carefully separate the muscles.

Show the thin sheets of connective tissue that bind the muscles together. Show also how the

muscles are attached to tendons. Pull the tendons to show how the toes are moved.

#### FOOD

Samples of different kinds of food may be used to illustrate the classification of foods.

**Proteid.**—White of egg is pure albumen, a well-known form of proteid.

(1) Show the pupil the effect of heat upon it.

(2) Scrape a piece of lean raw beef. The part that is scraped off consists largely of another form of proteid. The shreds that remain are connective tissue.

(3) Put some wheat flour in a little muslin bag, hold it under a stream of water and knead it until the water comes away almost clear. What remains in the bag is largely gluten, another form of proteid.

**Starch and sugar.**—Samples of raw starch, such as corn starch or laundry starch, may be shown. The test for starch is iodine. It gives starch a very dark blue color, which becomes a beautiful light blue when water is added.

(1) Get at a drug store an ounce of the tincture of iodine, a small spirit lamp, a little alcohol for the lamp, and three or four test tubes about six inches long.

(2) Put into a test tube about two inches of water, and about as much starch as will lie on the end of a pen-knife. Shake well and then boil for a few minutes over the spirit lamp, until the starch becomes clear.

NOTE.—To make a holder for the test tube, fold a piece of paper two or three times, wrap the middle of the paper round the test tube, and hold the tube over the flame by the ends of the paper. When you begin to heat the test tube, hold it a little distance from the flame, and move it around, so that the heat may not be applied to just one place. If it is, the glass will break.

Allow the contents of the tube to cool, pour a little into another test tube, and add a drop of iodine to the second tube. The iodine will give a very dark blue color. Dilute with water, and the color will become a beautiful light blue.

(3) Take a small piece of each of the following: bread, cooked lean meat, cooked fat meat, cooked potatoes, cooked white of egg, cooked rice, white sugar,



HOLDING THE TEST TUBE OVER THE  
SPIRIT LAMP.

soda biscuit. Put a drop of iodine on each. Show the pupil, by the blue color, which contain starch and which do not. Test other kinds of food for starch.

The test for the kind of sugar contained in milk is Fehling's solution, which is blue in color. Get an ounce of the solution and a few test tubes from a drug store. For convenience the tubes may be placed in a deep cup or glass. In one of the tubes put an inch of water and as much Fehling's solution. In another put an inch of fresh milk and as much Fehling's solution. Heat the first tube, and notice that the color does not change, even when the water boils. Heat the second, and you will find that the color will change to a reddish brown, showing the presence of sugar in the milk.

**Fats.**—Show samples of fats. Butter and lard are obtained from animals. Sweet oil and cotton-seed oil are obtained from vegetables.

**Minerals.**—Procure, at a drug store, samples of a few of the more common salts which are contained in food, such as calcium phosphate, sodium phosphate, sodium bicarbonate, and potassium chloride. An ounce or more of each of these may be put into small bottles, which should be labeled and kept for further use. Compare each of these salts with ordinary table salt.

If possible, secure samples of so-called mineral waters. Mineral waters contain, in solution, a larger amount of mineral matter than other water.

#### DIGESTION

**The teeth.**—Obtain samples of the different kinds of teeth from a dentist, or get the tooth of a sheep or pig, which will show the structure of the human tooth.

(1) Show the root, the crown, and the enamel to the pupil.

(2) Break a tooth with a hammer, and show the pulp cavity and the channels in the roots for nerves.

**Saliva.**—To illustrate the action of digestive fluids, the action of saliva upon starch is taken because every one is familiar with saliva. Saliva changes starch into a kind of sugar, the test for which is Fehling's solution.

(1) Put into a test tube about two inches of water and as much starch as will lie on the end of a penknife. Shake well, boil for a few minutes, and cool.

Put into another test tube about half an inch of saliva, and a very little of the boiled starch. Hold this tube in warm water for five or ten minutes and stir contents. Then pour half of contents into another tube or vessel.

Put a drop of iodine on a lump of white sugar, and

have the pupil notice the reddish brown color. Let a drop of iodine run down the side of the tube or vessel into the saliva and starch. If the saliva has changed all the starch to sugar, only the reddish brown color will appear, but if the iodine comes in contact with any unchanged starch, the reddish brown color will be followed by a dark blue, almost black, color. Dilute with water, and you will get the light blue color characteristic of the iodine test for starch.

(2) To the other half of the starch and saliva add an equal quantity of Fehling's solution. Boil, and the blue color of the solution will change to a red or reddish brown, showing the presence of sugar.

The following experiments may be made with a common soda biscuit:

(3) Put a drop of iodine on a small piece of biscuit and show the presence of starch by the blue color. Put the part of the biscuit stained dark blue into water; stir and dilute, and you will get the light blue color.

(4) Chew a piece of the same biscuit for half a minute; then divide what has been chewed into two parts. Add a little water to one part, and shake well. Put a little of the mixture into a test tube; add an equal quantity of Fehling's solution, and boil. A red or reddish brown color will be seen, showing the

presence of sugar, which has been produced by the action of the saliva on the starch of the biscuit.

(5) To the other part of chewed biscuit add a drop of iodine. The blue color seen shows the presence of starch and proves that saliva is able to change only a part of our starchy food to sugar.

**The stomach.**—Get a small piece of the wall of a pig's stomach. Have the pupil, with the aid of a magnifying glass, find the opening of the glands which secrete the gastric juice.

**The liver and pancreas.**—A liver and a pancreas from a sheep or a pig may easily be obtained from a butcher. These may be shown to the class.

#### CIRCULATION

**The pulse.**—(1) Have the pupil feel with the first finger for the pulse at the wrist. It is best found at a short distance from the base of the thumb, and just a little to the outer side of the tendons. Have the pupil count the number of beats to the minute.

**The heart.**—Get a sheep's heart from a butcher. Ask him for one with the sac still surrounding it, and request him to leave the large artery and the veins for two or three inches above the heart.

(2) Cut open the sac which surrounds the heart and



FEELING THE PULSE.

show its smooth, slippery lining. This prevents friction between the sides of the heart and the enclosing sac.

(3) Cut through the walls of the heart to show its cavities.

Push a pencil, or

small twig, down through the arteries and veins to show that they open into the cavities.

#### THE LUNGS

Procure the fresh lungs and windpipe of a sheep. Wash away all traces of blood, and remove fat and other unnecessary tissue.

(1) Have the pupil examine the windpipe, and notice its rings of cartilage. The lungs may be inflated by pushing a glass tube well down into the windpipe and blowing into it. A better way is to insert the tube of a bicycle pump well into the windpipe and then force air into the lungs with the pump.

(2) Cut away the parts of one lung that surround the bronchus. Expose the bronchus and show its branches. Follow some of these branches till they become quite small.

(3) With a tape line measure the chest of a pupil on the outside of the clothing. Have the class note the size after a complete expiration and again after a full inspiration, to show that the chest increases in size during inspiration.

(4) Have each pupil count the number of times he breathes in a minute. But as no one is apt to breathe normally when he is thinking about it, suggest to the pupil to count the number of respirations to the minute of some one who does not know that he is being watched.

(5) Expired air contains considerable water. To show this, breathe on a mirror and let the pupil see the resultant moisture.

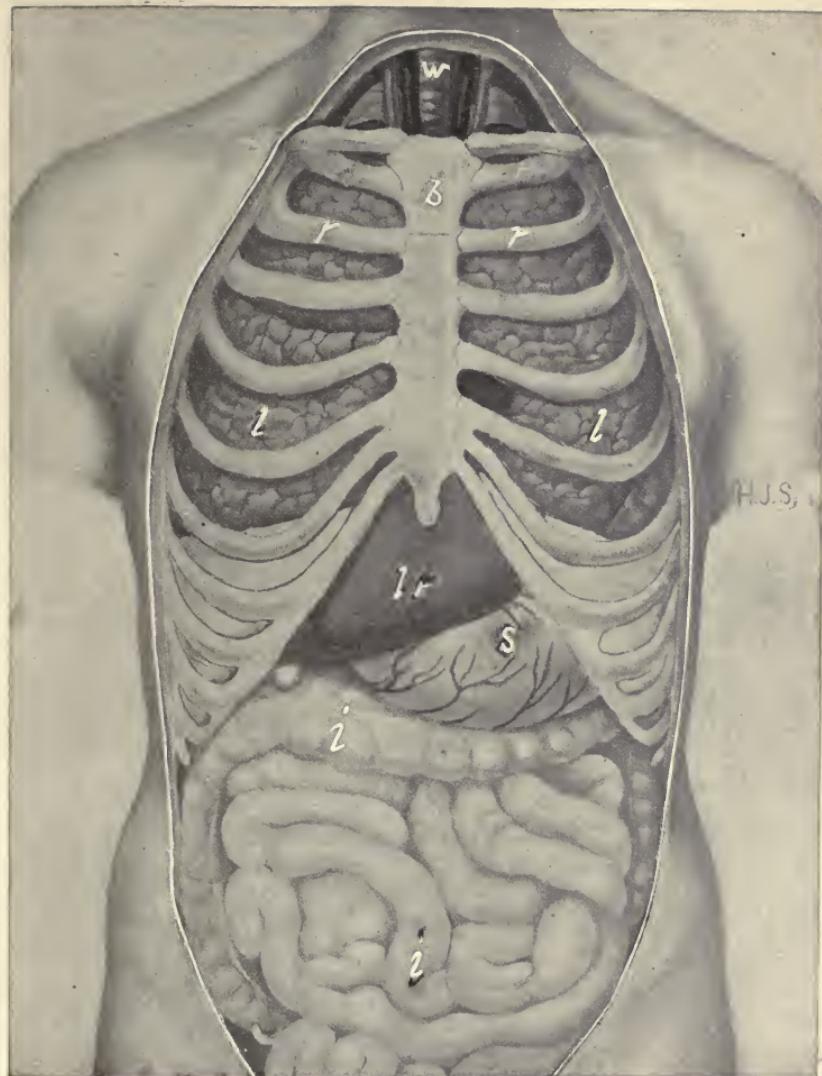
(6) Expired air contains carbon dioxide. To show this, have the pupil blow gently several times through a straw, or a glass tube, into a glass of lime water. The lime water soon becomes milky in appearance, because the carbon dioxide unites with the lime in the water, to form carbonate of lime.

Lime water may be obtained at a drug store, or it may easily be made. Take a quart of water and put into it a handful of slaked lime. Stir it well every ten or fifteen minutes and at the end of an hour let it settle. Remove any scum lying on the top and pour off the clear liquid.

#### THE BRAIN

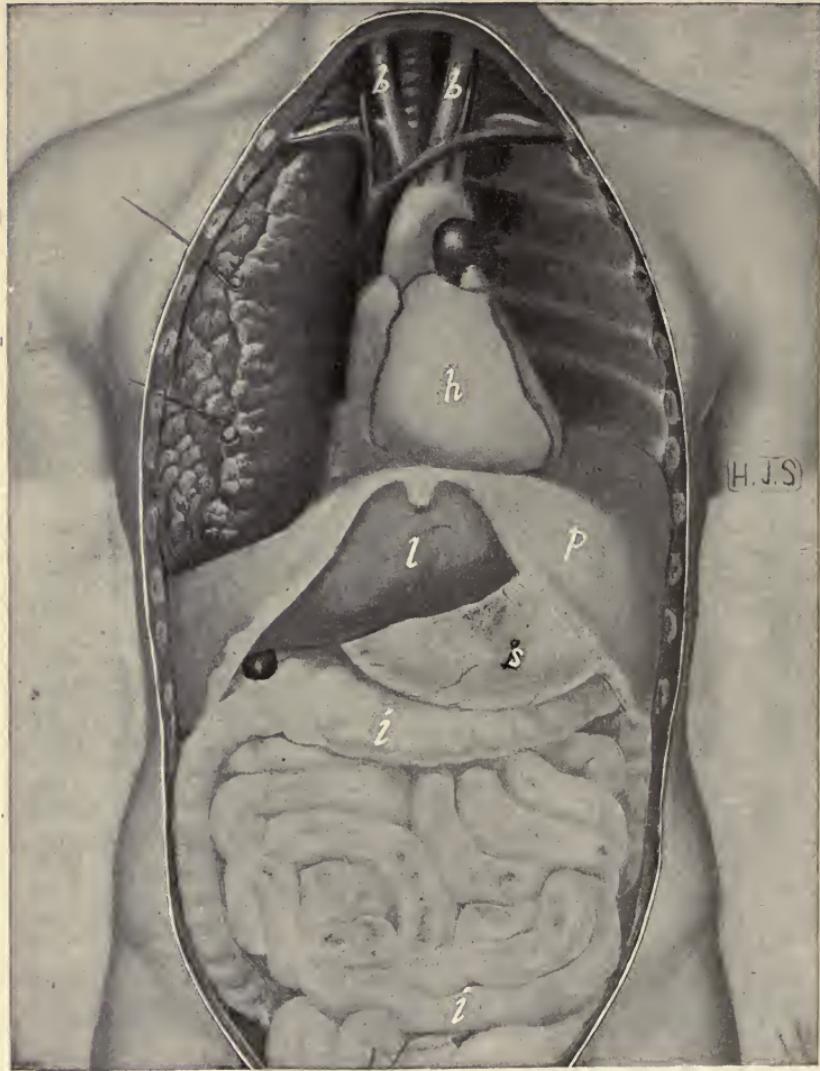
Ask the butcher to saw open the skull of a sheep carefully, and remove the brain without injuring it. Procure from him three or four inches of the spinal cord of the sheep along with the brain.

- (1) Show the deep fissure which divides the brain into two equal parts. Show the wrinkled surface of the brain, and pass a pencil down into the hollows to show their depth.
- (2) Point out some of the nerves that start from the under surface of the brain.
- (3) Show that the brain, as the spinal cord, extends downwards into the spine.



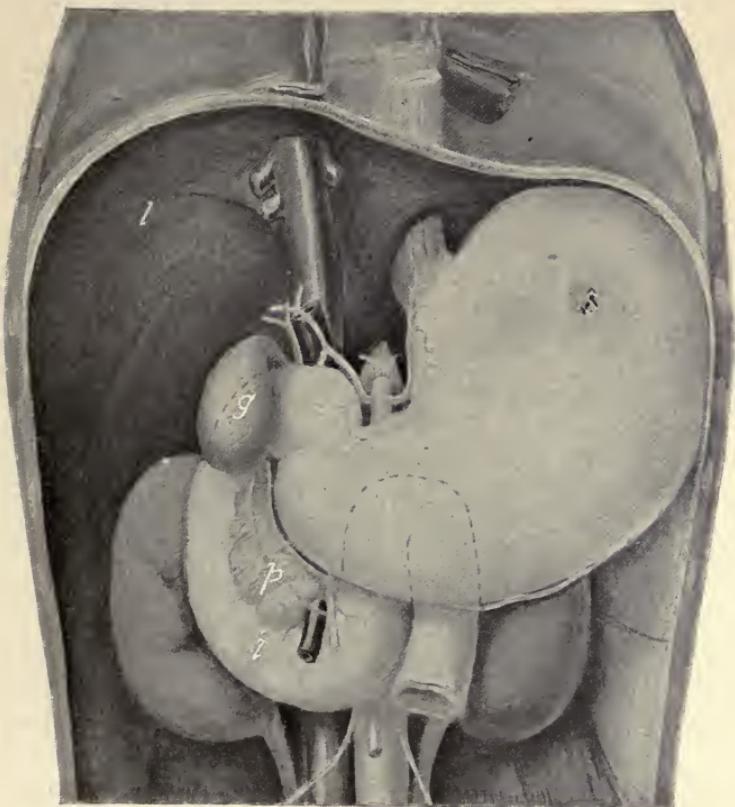
KEY TO THE PICTURE ON PAGE 11.

*w*, windpipe ; *b*, breastbone ; *r*, ribs ; *l*, lungs ; *lr*, liver ; *s*, stomach ; *i*, intestine.



KEY TO THE PICTURE ON PAGE 14.

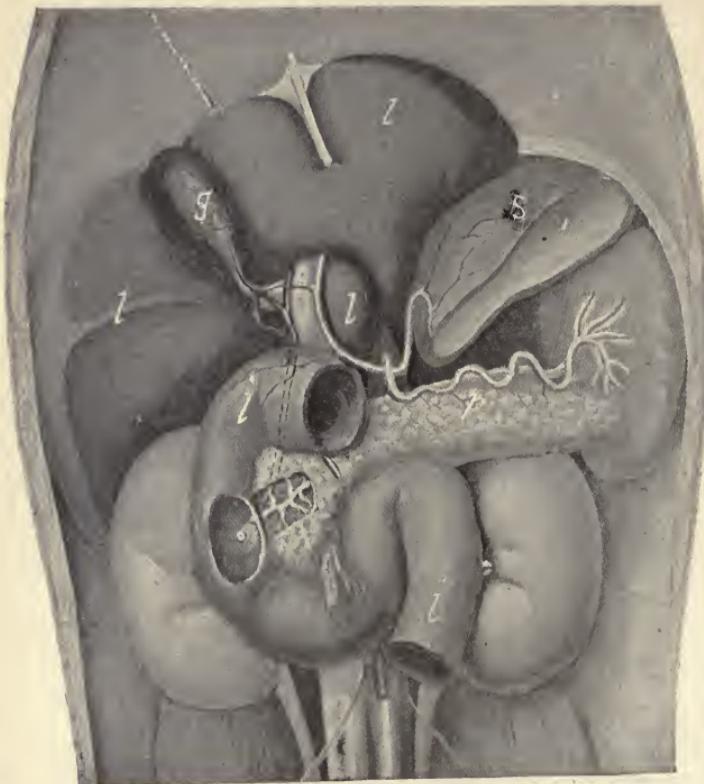
*b*, blood tubes ; *h*, heart ; *p*, partition between chest and abdomen ; *l*, liver ; *s*, stomach ;  
*i*, intestine.



KEY TO THE PICTURE ON PAGE 66.

Stomach in its natural position.

*s*, stomach ; *l*, liver ; *g*, gall bladder ; *p*, pancreas ; *i*, intestine.



KEY TO THE PICTURE ON PAGE 71.

Part of the stomach cut away, to show pancreas.

*l*, liver ; *g*, gall bladder ; *s*, stomach ; *i*, intestine ; *p*, pancreas.

## GLOSSARY

**Ab-do'men**, the lower part of the trunk.

**al-bu'men**, a kind of proteid, as white of egg.

**a-nat'o-my**, the science that tells of the parts of the body and their arrangement.

**a-or'ta**, the great artery that starts from the left side of the heart.

**ar'ter-y**, a blood tube through which blood flows away from the heart.

**bile**, a bitter yellowish fluid made from the blood by the liver.

**cap'il-la'ries**, very small blood tubes that connect the arteries and veins.

**car'bon di-ox'ide**, a colorless gas produced by respiration and also by fermentation.

**car'ti-lage**, gristle.

**cir'cu-la'tion**, movement of the blood through the blood tubes.

**cor'pus-cle**, a blood cell.

**di-ges'tion**, the process of dissolving and changing food, that it may nourish the body.

**dis'til-la'tion**, the process of separating one substance from another, or others, by driving it off in vapor and afterwards condensing it.

**en-am'el**, the hard covering of the crown of a tooth.

**e-soph'a-gus**, the tube through which the food passes from the mouth to the stomach.

**ex'pi-ra'tion**, the act of breathing out air from the lungs.

**fer'men-ta'tion**, the process by which one substance is changed into others by the action of ferments.

**gas'tric juice**, a thin, acid fluid made from the blood by the glands of the stomach.

**gland**, an organ that can take material from the blood and make new material of it.

**hy'gi-ene**, the science that tells how to preserve and improve the health.

**in'spi-ra'tion**, the act of breathing air into the lungs.

**in-tes'tine**, the part of the digestive tube that is below the stomach.

**i'ris**, a thin colored curtain in the front part of the eye.

**lac'te-al**, a little tube, in a villus, that takes up digested fat.

**lig'a-ment**, a band of connective tissue that holds together the bones of a joint.

**nar-cot'ic**, a drug which in small doses produces sleep, and in large doses produces stupor or even death.

**nic'o-tine**, a poison contained in the leaves of tobacco.

**or'gan**, any part of the body that performs a special work.

**ox'y-gen**, one of the gases of which air is composed.

**pan'cre-as**, a gland that is behind the stomach.

**pan'cre-at'ic juice**, a digestive fluid made from the blood by the pancreas.

**pro'te-ids**, a class of substances that exists in almost all animal and vegetable tissues.

**pulse**, the beating of the arteries as the blood is forced through them by the heart.

**sa-li'vea**, the digestive fluid secreted by the salivary glands; spittle.

**sal'i-va'ry glands**, the glands that make saliva from the blood.

**skel'e-ton**, the bony framework of the body.

**spine**, the backbone.

**sprain**, a straining or twisting of the ligaments of a joint.

**stom'ach**, a muscular sac, or enlargement of the tube in which digestion is carried on.

**ten'don**, a strong cord or band of connective tissue to which an end of a muscle is attached.

**tis'sue**, one of the kinds of material of which an organ is composed.

**vil'lus**, a hair-like projection from the inner surface of the small intestine.

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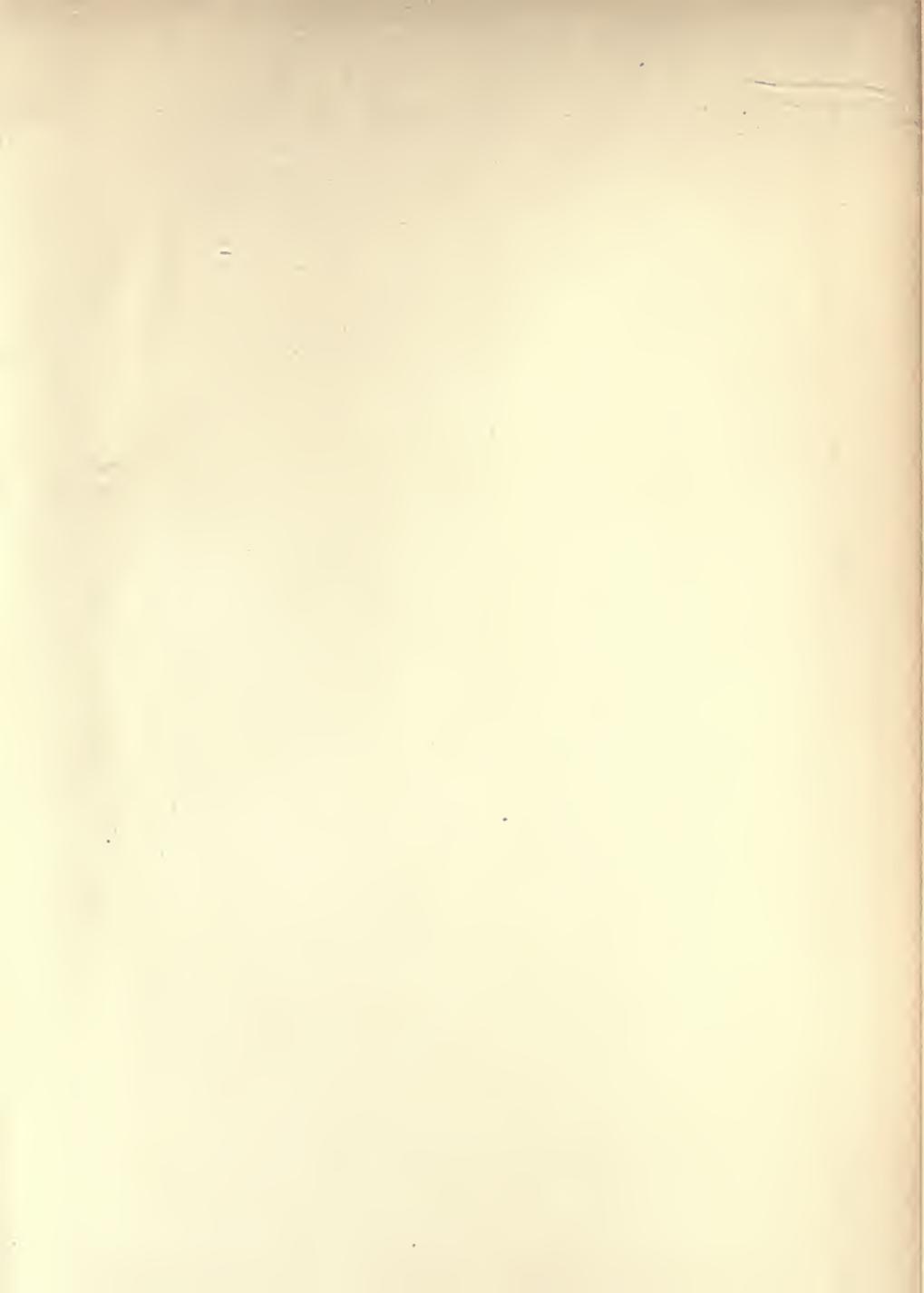
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